Pollution of the Amur River Attains Crisis Proportions

Khak Mun Jen
Scientific Advisor, Institute of Water and Ecological Problems
Far Eastern Branch of the Russian Academy of Sciences

After the Second World War, advances in synthetic chemistry in developed countries led to the production in vast quantities of chemical fertilizers and pesticides, which were supplied to the agriculture and livestock industry at low prices. These synthetic chemical substances eliminated pests and weeds and contributed to an increase in crop yields, playing a decisive role in solving the serious food shortages being experienced at the time. However, as a result of the prolonged use in recent years of chemical fertilizers and pesticides with the aim of increasing crop volumes, the soil ecosystem of farmland has been devastated and these products frequently have an adverse effect on the environment and human health.

At an international soil science conference held in Kyoto in 1990, a declaration was issued that called for agriculture that conserved the environment. Later, a campaign to reduce the use of chemical fertilizers and pesticides was promoted in Japan and the current aim is to induce the government to adopt a policy of eliminating the use of chemical fertilizers and pesticides altogether in the near future.

Hitherto, hazardous synthetic organic substances that pollute the environment, such as non-biodegradable pesticides, chemicals and solvents, were disposed of in landfill sites, discharged into rivers and seas, or incinerated; however, such disposal methods are now prohibited. A safe method of disposing of hazardous non-biodegradable chemicals that have been banned has yet to be developed, so a backlog of them has accumulated. Naturally, regulations concerning the environment differ in each country and chemicals that are banned in one country are exported to other countries where their use is permitted. Obviously, however, even if one makes unilateral efforts to conserve the environment, these efforts are rendered meaningless if pollutants are being discharged in a neighboring country. In other words, a country whose seas, lakes or rivers border the polluting country will suffer the same pollution.

For instance, regulations state that the standard biochemical oxygen demand (BOD) of rivers flowing into

Tokyo Bay should be 40ppm or less, but the BOD of water flowing into the sea from China's Yangtze River is 170ppm or more. The quality of wastewater flowing into Chiba City's sewage treatment plant, which is located in Tokyo Bay, is similar to that flowing into the sea from the Yangtze River. At Chiba City's sewage treatment plant, this kind of polluted water is discharged into Tokyo Bay only after its BOD has been reduced to 30-40ppm, which costs upwards of a billion yen annually.

Developed countries comply with environmental conservation regulations to the letter and strive to maintain a clean environment, but in developing countries there are still quite a few cases in which effluent from factories is discharged directly into rivers and seas without having been treated. For example, the River Danube, whose source is in Germany, converges with tributaries that flow into it from such Central European countries as the Czech Republic, Moldova and Bulgaria; it also passes through Austria, Hungary, Serbia and Montenegro (formerly Yugoslavia) and Romania before flowing into the Black Sea. However, the environmental conservation regulations of each country differ and there is no agreement on a common set of rules, so the water is discharged into the sea in its polluted condition.

The water in the Malay Peninsula's Malacca Strait is also seriously polluted, because the discharge of effluent from the neighboring country of Indonesia is not restricted by environmental regulations, and the people of Singapore are suffering as a result.

The Tumen River, which flows along the border between China and the Korean Peninsula, contains severely polluted water, mainly from tributaries that converge with it from the Chinese side. As this flows into Russia's Primorsky Territory, particularly Peter the Great Bay, Russians have expressed their displeasure about it. One reason for their dissatisfaction is the adverse effect the pollution has had on the fishing industry, as the poor water quality of the Tumen River has led to a progressive decline in marine produce resources.

I would now like to discuss the serious pollution affecting the Amur River (also known as the Heilongjiang in Chinese), which is the longest river in the North Pacific.

The marine resource potential - said to be the world's largest - of the Sea of Okhotsk is closely connected to the large quantities of nutrients that are carried into it by the Amur River. The Amur River, which is the source of these, is faced with large-scale pollution and has to confront a crisis that could inflict fatal damage to the international fishing industry.

With environmental pollution escalating due to such factors as rapid urbanization, an increase in population concentrations, the development and expansion of industry and mining, and intensive farming, the ravaging of the Amur River's ecosystem is a matter of grave concern for us today. Furthermore, soil pollution is increasing due to wastewater, human waste, and the excessive use of chemical fertilizers and pesticides; these pollutants then enter the rivers from the land when rivers flood due to heavy rain, causing a further deterioration in water quality. The solution of the pollution problem arising from this is the greatest issue currently being faced.

The Amur River originates in Eastern Siberia, at a latitude of 50˚ north, where the Shilka River, which flows down from the Siberian mineral zone about 10˚ east of Lake Baikal, converges with the Argun River, which flows through Mongolia, the northern part of Northeastern China and Manzhouli. The Amur is the North Pacific's greatest river, running 2,850km eastwards along the Russian-Chinese border and flowing into the Sea of Okhotsk at the Tatar Strait (Mamiya Strait). Furthermore, if the Sungari River (1,840km long; known as Songhuajiang in Chinese), the longest river in Northeastern China, and the Ussuri River are added, the total length of the Amur River is more than 4,350km. This great river splits into numerous channels as it flows along a vast alluvial plain; when it rains, the water spills over the banks of these channels, concealing the sandbars and turning the entire area into a huge lake. It is a very variable river: when the water level falls, the sandbars appear above the surface once more and the river is split into dozens of channels again. As very little snow falls, it is rare for the river to overflow its banks at the beginning of spring, but floods frequently occur in summer, when it rains a great deal. (See photographs 1 and 2.)

Recently, in China, the total area of farmland has increased due to a policy of reclaiming the land along the lower reaches of the Sungari River, and large quantities of chemical fertilizers and pesticides are used in intensive farming. Certain information suggests that they import and use such agricultural chemicals as germicides, herbicides and pesticides that are banned in Japan because they are highly toxic and have a long half-life.

According to the testimony of residents living near Lake Khanka, which lies a few dozen kilometers from Vladivostok, on the Chinese-Russian border, ducks and other waterfowl have disappeared and the odor of benzene has been detected in the area for the last two years, all of which may be due to the western side of the lake having been sprayed with a pesticide that emits a benzene compound. The residents of the Jewish Autonomous Region, about 200km away from the city of Khabarovsk, have also testified that they could smell benzene from the Chinese side of the Amur River, which is directly opposite their territory.

It is conceivable that such pesticides are being used on the reclaimed land along the lower reaches of the Sungari River. Local ecological researchers argue that it is difficult for pesticides containing benzene compounds that have entered rivers to be broken down within the natural environment, so they accumulate in the internal organs and body tissues of fish.

Fewer than five million people live near the Amur on the Russian side of the river, but the number of those living near the Sungari on the Chinese side of the river is in excess of 50 million. The large city of Harbin, which has a population of more than 3.5 million, does not have a purification facility for the city's wastewater and human waste is discharged untreated into the Sungari.

In 1990, when I visited Harbin at the invitation of the Heilongjiang Province Institute of Environmental Conservation, I discovered human and livestock feces floating on the surface of the Sungari while I was on a

pleasure boat headed for an amusement park called Taiyangdao (Sunshine Island), which is located on a sandbar in the river. That evening, the white skin of those Russians accompanying me who had sunbathed or swum near the park was suddenly covered with an allergic rash and they developed obvious physical abnormalities.

It is patently obvious that the water quality of the Amur River deteriorates at the confluence with the Sungari. The water of the latter, which contains a great deal of pollutants, is the color of cola; it has not mixed with the yellowish brown water of the Amur River even by the time it reaches a point 100km further east and one can still clearly distinguish the flows from the two rivers. There is no change in the color of the dirty water from the Sungari from the confluence of the two rivers until it reaches a point about 200km downstream, at which stage the blackish brown color gradually becomes weaker and eventually disappears.

The water from the Sungari River contains a lot of sludgy, viscous pollutants, and the river becomes more prone to eutrophication as a result. In addition to the rise in water temperature, the numbers of microorganisms and plankton increase, and the sticky, viscous polysaccharides that they secrete allow microscopic particles to clump together to form clusters, called flocks. These flocks become progressively heavier as they attach themselves to the remains of dead water flora and fauna, gradually sinking and accumulating in depressions in the riverbed as the river flows more slowly.

Just before the season when the river freezes and the volume of water falls, the photosynthetic activity of algae decreases, with a consequent reduction in the amount of oxygen produced; this causes the reduction mechanism to progress faster than the decomposition process. As a result, reducing substances such as hydrogen sulfide and mercaptan are generated and it is these that cause the river water to give off an abnormal stench.

When the temperature of the water falls further, the settling of the flocks progressively continues and they are deposited on the riverbed as sludge. These deposits are gradually covered with sediment and become trapped in depressions in the riverbed. Then, when the temperature of the water rises the following year, the microorganisms populating the riverbed become active and the decomposition of organic matter, such as the corpses of flora and fauna that have been submerged, intensifies. Large volumes of toxic gases, such as hydrogen sulfide, methane and toxic amino acids, are generated as a result and cause the sludge from the riverbed to rise rapidly to the surface. Algae such as cyanobacteria, diatoms and zooxanthella flourish in still waters separated from the main stream and create sticky polysaccarides. In addition, waterborne granular matter and the remains of dead algae sink to the riverbed once more and rot, causing sludge to accumulate. This is the main cause of what is called "algal bloom". The toxic substances generated by the proliferation of cyanobacteria and by the decomposition of dead flora and fauna can cause living organisms such as fish and shellfish to perish. (See photographs 3 and 4.)

In light of the fact that the water from the Sungari River is estimated to make up 40% of the total volume of water in the Amur River, it is obvious that the Sungari has a significant impact on the Amur.

Many of the species of fish populating the Amur River swim back up to the Sungari River before the river freezes, migrating to the southern part of Northeastern China for the winter. However, unfortunately, when the ice thaws the following spring, it is not unusual to see the white bellies of many large fish that have died, floating on the surface of the Amur River along with the ice. Very few of the fish that migrate to the Sungari River for the winter make it back to the Amur River safely. The Amur was once home to 150 species of fish, but a survey carried out by icthyologists has revealed that more than half of these have now become extinct. (See photographs 5 and 6.)

A special edition of the leading Russian newspaper Komsomolskaya Pravda (No. 2, February 2000) carried an article entitled *The Amur River Has Become A Drainage Ditch For Our Great Neighbor (China).*

For the indigenous people living alongside the Amur River, such as the Nanai and the Nivkh, fish is such an important part of their diet that they cannot live without it. (See photograph 7.) However, they frequently suffer the effects of this pollution: salmon and other fish become contaminated with toxic substances leading to the flesh of the fish giving off a foul odor and the people themselves developing the symptoms of food poisoning.

The sludge containing toxic substances is carried from the mouth of the Amur into the Tatar Strait. When autumn comes, salmon make for the Tatar Strait in order to swim back upriver to lay eggs. There is a strong possibility that salmon, which do not eat at all during the spawning season, are already becoming contaminated in the strait and at the mouth of the Amur, before swimming back upstream. The salmon, in whose bodies toxic substances have accumulated, die upstream after spawning; it is likely that the toxic substances become detached when their corpses decompose, thereby causing secondary pollution of the river.

Recently, the Amur River was polluted with oil and one often hears complaints that fish such as salmon and rainbow smelt smell of kerosene or crude oil. (See photograph 8.) Many of the people in that area are in the habit of preserving dozens of salmon with salt when the Amur River thaws, to provide themselves with food to see them through the winter. Before cooking the fish, they immerse the salmon in water for a day or two, to remove the salt; blue oil that smells of petroleum can be seen floating on this water. As a result, a not insignificant number of families end up having to feed to their livestock all the fish that they had carefully stored in barrels.

Russia has strict regulations regarding the use of pesticides and under the law on extensive agriculture, pesticides are almost entirely prohibited at present. Given this situation, it could well be that pesticides used in China cause the odor of oil and phenol emitted by the bodies of the fish. Non-biodegradable pesticides whose use is prohibited in Japan infiltrate the tissues and cells of the fish and when it is salted, heated or smoked, these substances break loose and cause the odor of oil or benzene.

According to a detailed survey carried out a few years ago by Dr. Fyodor Kot, a researcher at the Institute of

Water and Ecological Problems, which is affiliated to the Far Eastern Branch of the Russian Academy of Sciences, various heavy metals were detected in deposits gathered from the sea bed at the mouth of the Amur River and in the Tatar Strait, and these deposits were distributed over quite a wide area. The origin of these heavy metals is unclear, but Jilin Province, on the upper reaches of the Sungari River, is a mining area. Factories and other facilities developed for the mining, mineral processing and electrical industries when the region was occupied by Japan and known as Manchuria are still operating today, without water purification devices; heavy metals contained in the wastewater from these factories are discharged into the Sungari River and it cannot be denied that there is a possibility that they are carried as far as the mouth of the Amur River. (See photographs 9 and 10.)

As we can see from all of this, the pollution of the Amur River is caused by a diverse range of sources and the degree of pollution is increasing annually. There are limits to the ability of nature to purify water and there is concern that, if this pollution progresses, the ecosystems around the Amur River will be ruined and all those living in the surrounding region, including the indigenous people, will suffer greatly as a result. And it does not stop there; the pollution of the Tatar Strait could have an adverse impact on the environment of areas along the Japan Sea coast.

Every second, 10,800m^3 of water flows from the Amur River into the Tatar Strait. Part of this massive volume of fresh water flows into the southern part of the Tatar Strait, mixes with seawater from the Japan Sea and is dispersed. However, the majority of the water from the Amur River moves to the northern end of Sakhalin, where it flows around the cape due to the currents of the Sea of Okhotsk; it is then swept southward and, as it mixes with the seawater, it flows from Wakkanai, in northern Hokkaido towards Etorofu, one of the Kuril Islands. Pollutants are carried along with the water from the Amur and we cannot ignore the possibility that they may be washed ashore on Hokkaido. This fact should become clear if a survey of the trajectory of ice flowing from the Amur River at the beginning of spring were carried out. Incidentally, some fishermen have reported finding freshwater fish among the ice flows that gather along the coast of Wakkanai. It is possible that these belong to the same species as the fish found in the Amur River.

Thus, the pollution of the Amur River is a major problem of North Pacific proportions, which Russia, China and Japan must tackle together. It would be no exaggeration to say that even putting it off until tomorrow could be leaving it too late.

[Translated by ERINA]

Khak Mun Jen
Scientific Advisor, Institute of Water and Ecological Problems
Far Eastern Branch of the Russian Academy of Sciences

Biographical Data

Born in southern Sakhalin in 1936. After graduating from the Faculty of Biology and Soil Science at the Far Eastern National University he obtained his doctoral candidate degree at Leningrad University. At the Siberian Branch of the Soviet Union Academy of Sciences, he was successively a researcher at the Sakhalin General Research Institute, Director of the Microbiology Research Center, and Director of the Khabarovsk General Research Institute. He was then appointed Deputy Director of the Institute of Water and Ecological Problems, part of the Far Eastern Branch of the Soviet Union Academy of Sciences, as well as becoming Technical Advisor to the Japanese company Japan Ecotrust.

His publications include *Soil Microbe Clusters of the Pacific Islands, The Formation and Stabilization of Soil Microbe Clusters, The Fermentation and Composting of Organic Waste,* and *Why Do We Now Use Microbial Rather Than Organic Methods in Farming?* In addition, he has discovered five new types of microbe, including manganese bacteria and marine chromatic bacteria in volcanic ash, and has published his work in various academic journals. He obtained his doctorate from the Microbiology Research Center for his thesis on soil and the formation of microbe clusters using volcanic ash as a model; he was also awarded a medal by the Soviet Union in recognition of his work in this area.

In addition, he has been active in Japan, giving seminars and lectures at Tohoku University, Nagoya University, Kyoto University, Niigata University, Mitsui & Co., Yamasa Soy Sauce and regional agricultural cooperatives in various prefectures.