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Environmental problems in and around Vladivostok, Russia

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Abstract - The existing environmental problems in and around Vladivostok can be resolved by some policy and management actions. In particular, construction of sewage treatment plant to clean-up municipal wastewaters and reduction of pollutant emissions to the atmosphere are needed. The existing city landfill, which capacity has been exceeded long time ago, should be closed and new polygon for garbage disposal should be established.

I. Introduction

A few environmental problems in and around Vladivostok will be discussed in this presentation. First, situation with urban air and soil pollution in Vladivostok and Primorsky Kray. Second, marine pollution and its municipal and industrial sources. And, last but not least, the current situation with radioactive contamination.

II. Urban Air and Soil Pollution

The Primorsky Kray Service on Hydrometeorology and Environmental Monitoring (Hydrometservice) is responsible for monitoring of air pollution. There are 13 monitoring stations located in 8 cities of Primorsky Kray (Fig. 1). Monitoring parameters and methods are shown in Table 1. Sampling (manual) is being done three times a day, at 07:00, 13:00 and 19:00 local time.

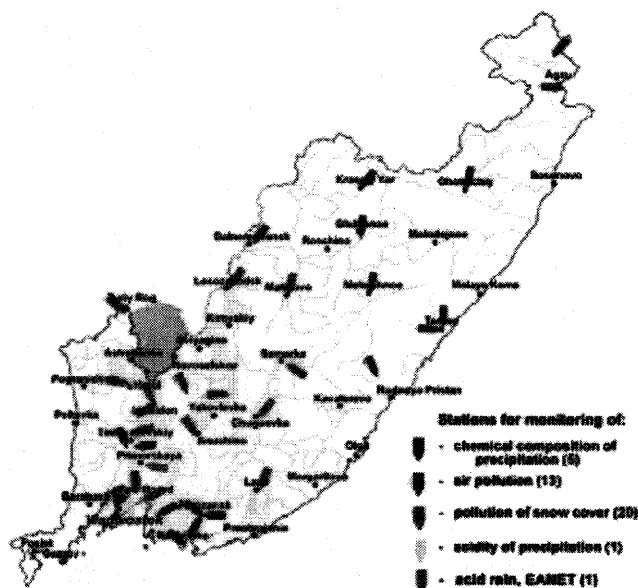


Fig. 1. Stations for monitoring of air pollution and atmospheric deposition in Primorsky Kray

TABLE I
Air pollution monitoring parameters in Primorsky Krai

Parameter	Method
NH ₃ , NO, NO ₂ , SO ₂ , H ₂ S, Formaldehyde	Spectrophotometry
Fe, Cd, Co, Mn, Cu, Ni, Pb, Cr, Zn	Atomic Absorption Spectrometry
CO	Electrochemical
Suspended solids (SS)	Gravimetric
SO ₄	Nephelometric
Benz(a)pyrene	Luminescence

According to 2002 data, air in Primorsky Krai was mostly contaminated by NO₂ and benz(a)pyrene. The highest NO₂ levels were registered in Artyom, Ussuriysk and Vladivostok (up to 0.28 mg/m³ or 7 times higher than the maximum permissible concentration (MPC)). The highest B(a)P contents were measured in Partizansk, Ussuriysk and Vladivostok (up to 14 ng/m³ or 14 times higher than MPC).

In Vladivostok, the main sources of NO₂ are emissions from industrial enterprises (including power plants) and from automobiles. The sources of B(a)P are coal combustion (power plants, heating) and, to a lesser extent, diesel engines.

Application of biomonitoring methods can provide additional information on air pollution in the cities. Some results of lichen indication for Vladivostok [1] are shown on Fig. 2 as an example. From these pictures, it can be seen that the areas with high air pollution levels (shown in dark brown color) are situated around industrial enterprises and along major highways. It's interesting to note that in 1985 and 1989 situation is a bit different, i.e. pollution levels are fluctuating in time. The areas of high levels of soil pollution are also situated near industrial enterprises and along major roads.

III. Marine Pollution and its Municipal and Industrial Sources

The main sources of marine pollution around Vladivostok are as follows: 1) discharges from industrial enterprises; 2) river runoff; 3) dredged material dumping; 4) municipal wastewater discharges; 5) atmospheric deposition of pollutants; and 6) discharges from ships. In this part, we will consider mainly pollutant inputs from municipal and industrial sources. The effluents of municipal wastewaters are situated in Amursky and Ussuriysky bays as well as in Golden Horn inlet, the inner

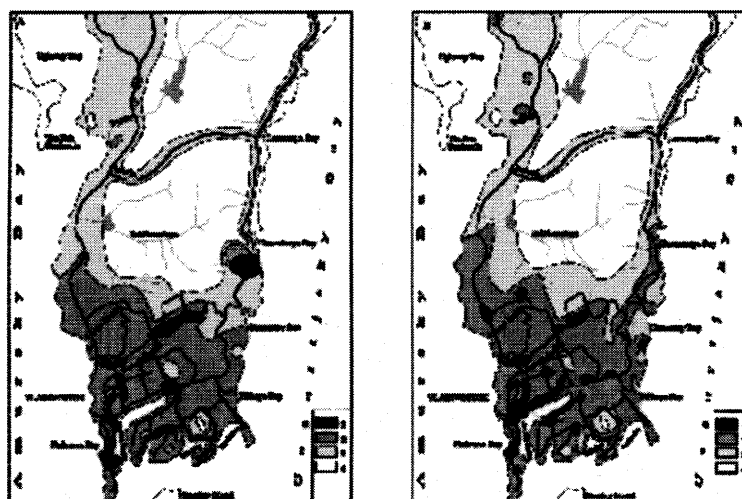


Fig. 2. Results of lichen indication of air pollution in Vladivostok in 1985 (left) and 1989 (right)

harbour of Vladivostok. Annual discharge of wastewaters from Vladivostok is about $420 \cdot 10^6 \text{ m}^3$, most of them untreated [2]. As a result of large amount of pollutants entering the marine environment with municipal and industrial wastewaters, concentrations of nutrients, petroleum hydrocarbons and trace metals in seawater and bottom sediments around Vladivostok are quite high and sometimes exceed the maximum permissible levels established in the Russian Federation [3 - 6] (Fig. 3).

Another source of pollutants entering the marine environment is the old city landfill situated on the shore of Ussuriysky bay. Because the capacity of this city landfill has been exceeded long time ago, the material accumulated in the landfill over the years (containing metals, plastic and other kinds of garbage) is sliding directly into the sea. As an example, the distribution of some trace metals in bottom sediments around Vladivostok is shown in Fig. 4.

The highest contents of Pb, Zn, Cu and Ag were found near wastewater discharges in Amursky and Ussuriysky bays as well as near the landfill in Ussuriysky bay. These findings were confirmed by analysis of trace metals and chlorinated hydrocarbons in mussels *Crenomytilus grayanus* and *Modiolus kurilensis* [7 - 11]. Distribution of Zn in bottom sediments, mussels *Crenomytilus grayanus* and oysters *Crassostrea gigas* is shown on Fig. 5 at several stations around the city landfill site (Ussuriysky bay).

The influence of the city landfill on distribution of trace metals in the marine environment around Vladivostok has been shown also by Anikiev and co-authors [12].

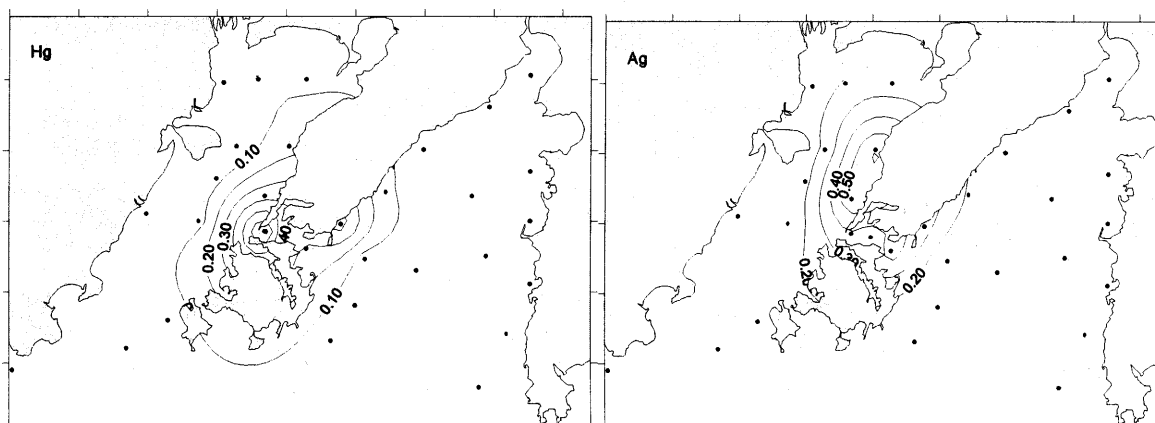


Fig. 3. Distribution of mercury (left) and silver (right) in bottom sediments around Vladivostok in 1994 (ppm)

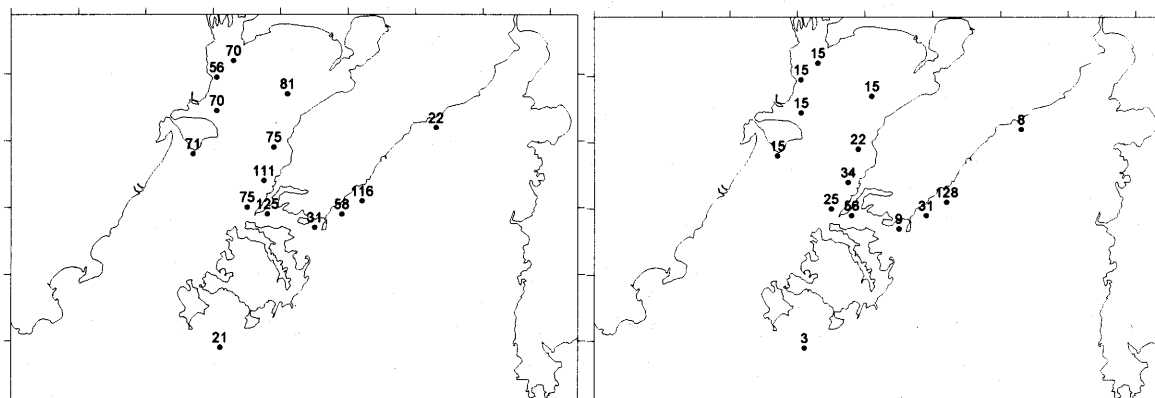


Fig. 4. Distribution of zinc (left) and copper (right) in bottom sediments around Vladivostok in 1996 (ppm)

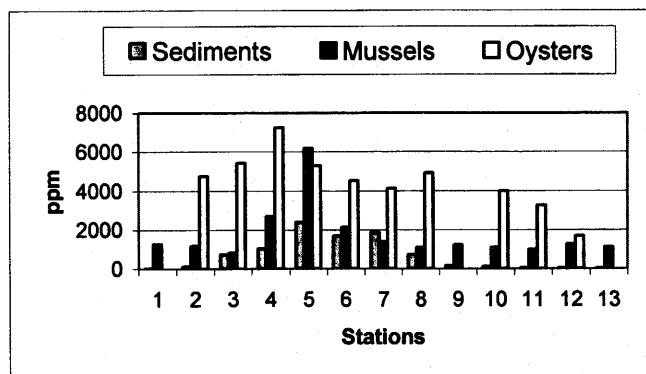


Fig. 5. Distribution of zinc in bottom sediments, mussels and oysters of Ussuriysky bay near Vladivostok city landfill

IV. Situation with Radioactive Contamination

The main inputs of artificial radionuclides to the marine environment of Peter the Great Bay are as follows: 1) global atmospheric fallout; 2) river runoff; 3) discharges from navy facilities situated along the coasts of the bay. The decommissioning of nuclear submarines and their subsequent dismantling is carried out at the Zvezda shipyard. The refueling facilities are located in Bolshoy Kamen and Chazhma bays. The storages of liquid and solid radioactive wastes are situated along the eastern coast of Ussuriysky bay and along Strelok bay (Fig. 6). Because these storages have not enough capacity, there is a potential threat to the marine environment around Vladivostok [13].

In 1985, the accident with the reactor of nuclear submarine took place at the navy facility in Chazhma bay with the total activity release of about 260 PBq of short-living isotopes, ^{60}Co and ^{54}Mn [14]. As a result, bottom sediments in Chazhma bay, Strelok bay, and the limited area in Ussuriysky bay were contaminated by ^{60}Co . In 1985, maximum activities of ^{60}Co were about $78 \cdot 10^3 \text{ Bq/kg}$ [14]. In 1994-1997, about a decade after the accident, high amounts of ^{60}Co were still found in bottom sediments of these areas [15].

Although in fishing and recreational areas of Peter the Great Bay levels of radionuclide activities in seawater and bottom sediments are low and caused mainly by global atmospheric fallout, regular observations of radioactive contamination (including marine biota) are necessary to assure safety of local population and tourists.

Recently, the floating facility to process low-level liquid radioactive wastes from the dismantled nuclear submarines has started its operations in Bolshoy Kamen bay. This facility (called Suzuran in Japanese) has been constructed with financial assistance of the Government of Japan.

V. Summary and Conclusions

In order to resolve the environmental problems in and around Vladivostok, some policy and management actions are needed: 1) to close the existing city landfill; 2) to construct sewage treatment plants; 3) to reduce pollutant emissions to the atmosphere. It is also extremely important to continue international cooperation in radioactive waste processing during nuclear submarine decommissioning.

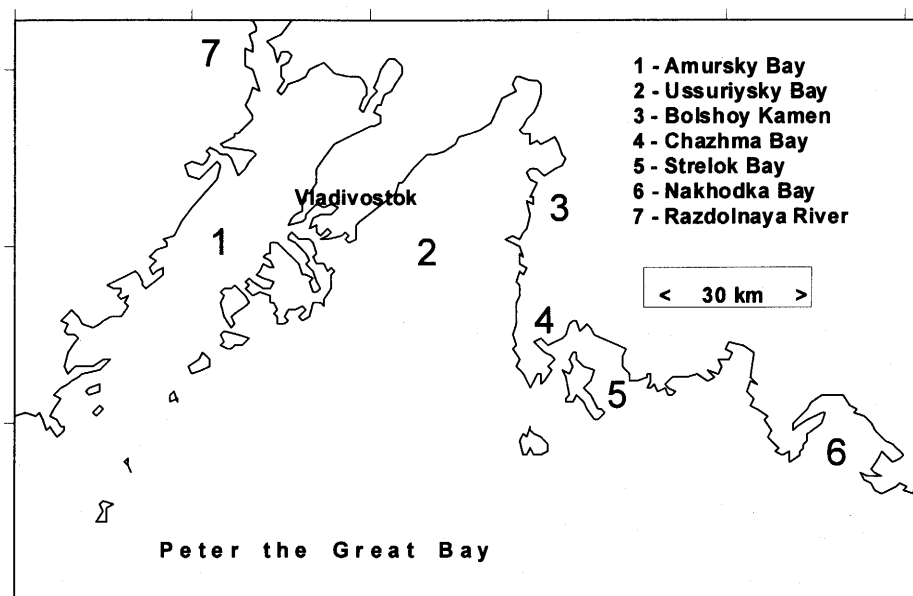


Fig. 6. Peter the Great Bay

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