RADIOCAPACITY:

PROGNOSIS OF POLLUTION AFTER NUCLEAR ACCIDENTS

V.L. Korogodina[1], V.I. Korogodin[1], Yu.A. Kutlakhmedov[2]

[1]Joint Institute for Nuclear Research, Dubna, Russia
[2]Institute for Cellular Biology and Genetic Engenering, Kiev, Ukraina

INTRODUCTION

All ecological systems have an inherent fundamental peculiarity to accumulate and strongly keep back radionuclides got into them. Maximal ammount of radionuclides in ecosystem, which doesn't yet violates its general trophic functions (productivity, conditioniarity and reliability), can be named as a radiocapacity of a given ecosystem (1).

Let us consider some problems connected with radiocapacity of ecosystems (for example a water body system).

RADIOCAPACITY CALCULATIONS

Water bodies consist of three components: water, soil and biota. Getting into water, radionuclides rapidly and evenly are distribute in it. At the same time radionuclides transfer to the floor of the water body and various live organism (biota). As time goes on, radionuclides which get into a water body in amounts of A, are distributed by its components according to the formula

$$A = B \cdot S \cdot (H + h \cdot K_1 + c \cdot H \cdot K_{2)}), \qquad (1)$$

where B is the critical amount of radionuclides per unit volume of water; S is a surface square of water body; H - its average depth; h - thickness of the sorbing layer of body floor; c - concentration of biota in water body; k_1 and k_2- transfer coefficients of radionuclides into biota and body floor (usually $k_1 \approx k_2 \approx 10^2$-$10^3$). If $h >> c \cdot H$ (it is usually observed), then formula (1) is simplified to formula (2):

$$A = B \cdot S \cdot (H + h \cdot K). \qquad (2)$$

One can see, a term connected with biota is vanished. However, in any water body contaminated with radionuclides, biota plays a role of three functions: accumulation of radionuclides from water; transfering them to the floor of water body; and what's more important - maintenance of such a type of physical-chemical state of floor deposits, which prevent desorption of radionuclides from them.

A firm sorption of radionuclides in floor deposits is observed at $pH \geq 7.0$. Under the lower magnitude of pH a desorption process is started, which comes close to its maximum value at $pH \approx 5.0$. The decreasing of pH from 7.0 to 5.0 is generaly associated with biota dying off in water body.

Biota state determines a critical value of radionuclides in contaminated water body, such a concentration B, to which biota is still able for normal operating ($B \approx 10^3$-10^4 Bk/l).

RADIOCAPACITY FACTOR OF ECOSYSTEMS

By performing some necessary investigations it is easy to determine S, H, h, and k for any water body. To compare radiocapacity of various water bodies one can use the following unitless quantity:

$$F = \frac{h \cdot K}{h \cdot K + H}. \qquad (3)$$

It can be named as an 'radiocapacity factor'. It shows what part of radionuclides is firmly sorbed by floor deporsits. For the majority of water bodies (exept swamps) $F \approx 0.7$-0.9.

The radiocapacity factor F and a critical value B of radionuclides into the ecosystem can be estimated for different types of ecosystems (see table 1)

Table 1. Approximate values for F and B for different ecosystems

Ecosystem	F	B (Bk/km^2)
Desert	0.1	10^{11}
Meadow	0.3	10^{13}
Like, river	0.9	10^{12}
Woodless slope	0.2	10^{11}
Forest slope	0.6	10^{12}

Knowing F and B for different landscapes, one can estimate their possible role as desactivators in the case of radionuclide contamination. All that gives us a possibility to make a forecast when and what kind of countermeasures must be taken.

PROGNOSIS OF POLLUTION OF THE DNIEPER CASCADE WATER BODIES

After the Chernobyl accident radionuclides pollutions of large areas of Byeloruss, Russia and Ukraine take place.Practically, all these areas are arranged about the Dnieper cascade square. Bellow Chernobyl the Dnieper consists of six large water bodies which drain into the Dnieper-Bug lagoon. Water exchange is quite small in these water bodies (close to $3 \cdot 10^2$ volume per year), that allows one to apply the method described above to this system.

Evaluation of the basic parameters of the Dnieper water bodies is presented in table 2.

Table 2. Factors of radiocapacities of the Dnieper cascade water bodies.

Water body	S (km^2)	H (m)	h (m)	k	F
Kiev	920	4	0.1	100	0.7
Kanev	690	4	0.1	50	0.6
Kremenchug	2250	6	0.1	800	0.8
Zaporozhye	570	4	0.1	100	0.7
Dnieper	410	8	0.1	230	0.7
Kakhovka	2150	8	0.1	280	0.7
Factor of radiocapacity of the whole cascade					0.9994

Calculations in three last columns are done for ^{137}Cs. We notice, the factor F for the whole cascade is much higher (about 0.9994) than for each water body in separate. It implies that floor deposits sorb and firmly keep back 0.9994 part of initial ^{137}Cs radionuclides during water transportation over the cascade from the Kiev water body to the Kakhovka one. Only 0.0006 part arrives to the Dnieper-Bug lagoon. Estimations have been done in 1988 (2).However, seven years later the differences between radionuclides contaminations of Dnieper cascade water bodies are approximately the same, as they were forecasted soon after Chernobyl accident.

CONCLUSION

The notions of `radiocapacity of ecosystems' and the `factor of radiocapacity' are determined. It is shown, that analysis of ecosystems in radiocapacity terms allows one to forecast for a long time the distribution of radionuclides over the polluted areas and determine countermeasures in all regions susceptible to risk. For example, the Dnieper cascade water bodies is observed.

REFERENCES

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