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...OCAPACITY MODEL APPLIANCE FOR ...TION OF RADIATION FACTOR IN A LAKE ECOSYSTEM

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... ...ach to creation of an ecological standardization system is offered. Such system ... ...gienic standardization system. Basing on the radiation capacity model and theory ...defining of critical biota condition on an example of a lake ecosystem is offered. ... of a critical radiation dose on the given biota, through radiocapacity models the ... pollution of the ecosystem's components are determined. The levels of permissible ...ed as such, at which radiation dose on the critical biota of the lake may not exceed

...ation doses on the biota; radiocapacity of ecosystems.

... standardization of ... radionuclides release ...ant, because there is a ... ...ese processes not only ... ...ch dominate in modern ... ...gical standardization. The ... modern ecology concerning ... for the biota in case of observing ... is not always true, is not always ... showed by modern researches and ... it is connected with the facts ... to avoid negative influence of ... usually cannot do this.

... publications

...ogical paradigm, when the safety of ...ota is defined by norms of people's ...ploitation, doesn't stand up to ... why the International Comission ... Protection in publication №80 set a ... a system of ecological ... based on reaction of the biota on ...ation doses. [2, 4]. The variants are ... in this article, when the radiological ...rdization on the biota is estimated in ...eaction of the critical (the most ...) kinds of organisms. But it is to be ... the critical kind for one ecosystem may ...itical for other types of ecosystems [2, 4]. ... it became necessary to develop other ...es. The substantiation of this need follows ... this article.

The objective of the work: to built the approaches to principles of substantiation and creation of ecological norms on permissible levels of radiative effect on the ecosystems' biota, which differs from the current hygienic rating system. The thing is that in the situations of hygienic standards adherence the dose effects on the ecosystems' biota may be critical.

3. Results of the research

In the most radiological situations the biota in the environment where it grows is exposed to external (from the exposure sources outside the biota) and internal irradiation (from incorporated in the tissues radionuclides). In the irradiation biocenosis for the experimental organisms the exposure sources may become incorporated (accumulated) radionuclides, contained in contiguous organisms. For certain organs of plants and animals external are also those sources, which are contained in other parts of this plant or animal.

In case of biocenosis contamination by artificial radionuclides initially the radioactive substances are contained on the ground and water surface contacting with plants or animals. Only after a certain time period under influence of wind, downfalls, biomass increase radionuclides are being reallocated within the abiotic constituent of the ecosystem and as result of migration processes or anthropogenic measures shift into the depth of the ground and body of water.

In case of radionuclide emissions in the environment the need arises to define the boundary values of radionuclides intake into the ecosystem,

...sed significant changes in the

... for evaluating the maximum ...des release into the ecosystem ... the annual exposure rate. In the ...ov and V.G. Tsytsuginov [2] ... doses on ecosystems in the form ... was introduced (Table 1).

...s that the actual dose limit for ... and "storage" in ecosystems ... may be dose rate that does not ... year when visible ecological ...ed on the scale. According to the ...ground exposure rate of 0.4–4.0 ... to the concentration of ^{137}Cs kBq/kg in the ecosystem or its ... and aquatic plants) and about ... ecosystem including terrestrials, ...Bq/kg in average. Calculations ... of dose factors developed by ...ented in Table 2 [1].

Table 1. Scale of radiation doses and zones in ecosystems

Number of dose limit	Zone	Exposure rate, Gy/year
1	Zone of radiation safety	< 0,001 — 0,005
2	Zone of physiological masking	> 0,005 — 0,05
3	Zone of ecological masking:	
3.1	terrestrials	> 0,05 — 0,4
3.2	hydrobionts and terrestrials	> 0,05 — 4
4	Zone of visible ecological effects:	
4.1	dramatic for terrestrials	≥ 0,4
4.2	dramatic for hydrobionts and terrestrials	≥ 4
4.3	disastrous for animals and plants	≥ 100

Table 2. Dose factors for the biota ecosystems on some radionuclides

	Internal irradiation, Gy/year/Bq/kg	External irradiation			
		Water, Gy/year/Bq/m^3	Air, Gy/year/Bq/m^3	Ground, Gy/year/Bq/kg	Vegetation, Gy/year/Bq/kg
	$4{,}1\ 10^{-6}$	$2{,}7\ 10^{-9}$	$1{,}72\ 10^{-6}$	$4{,}02\ 10^{-6}$	$1{,}72\ 10^{-6}$
	$2{,}\ 88\ 10^{-8}$	0	0	0	0
	$3{,}44\ 10^{-6}$	$1{,}76\ 10^{-9}$	$1{,}43\ 10^{-6}$	$2{,}64\ 10^{-6}$	$1{,}43\ 10^{-6}$
	$3{,}52\ 10^{-6}$	$1{,}57\ 10^{-9}$	$1{,}43\ 10^{-6}$	$2{,}36\ 10^{-6}$	$1{,}43\ 10^{-6}$
	$2{,}86\ 10^{-5}$	$1{,}48\ 10^{-10}$	$7{,}73\ 10^{-8}$	$2{,}22\ 10^{-7}$	$7{,}73\ 10^{-8}$
	$2{,}64\ 10^{-5}$	$3{,}72\ 10^{-12}$	$2{,}35\ 10^{-9}$	$5{,}58\ 10^{-9}$	$2{,}35\ 10^{-9}$
	$9{,}92\ 10^{-7}$	$3{,}07\ 10^{-10}$	$2{,}83\ 10^{-7}$	$4{,}61\ 10^{-7}$	$2{,}83\ 10^{-7}$
	$1{,}12\ 10^{-4}$	$8{,}91\ 10^{-9}$	$6\ 10^{-6}$	$1{,}43\ 10^{-5}$	$6\ 10^{-6}$
	$2{,}5\ 10^{-7}$	$6{,}51\ 10^{-12}$	$6{,}01\ 10^{-9}$	$9{,}77\ 10^{-9}$	$6{,}01\ 10^{-9}$

... data in Table 2 allow us to calculate the ... doses of the wild biota in different types of ...ems.

...ological standardization in the lake ...stem. The simulation results of permissible ...es in lake ecosystem [3]

...ccording to the estimation of the maximum ...ssible radionuclides ^{137}Cs concentration in the ...ents of the ecosystem the critical releases and ...ions into ecosystems can be estimated (we will ...with an example — the lake). Based on the model ...adiocapacity of the lake ecosystem [3] we showed ... for benthos of benthal deposits of a freshwater basin maximum permissible radionuclides release into the pond (N_k) shall not exceed the following value:

$$N_k < \frac{LHS}{kF},$$

where L — calculated based on the dose limit of 4 Gy/year (limit) of ^{137}Cs radionuclides concentration in aquatic biota (600 kBq/kg);

S — area of the basin;

H — the average depth of the basin;

k — coefficient of radionuclides accumulation from water by benthal deposits;

F — radiocapacity factor of benthal deposits of the basin.

... the water column the ... release shall

... Cs accumulation ... of the water column.

... basin where $S = 2$ km^2, ... = 0.7 critical value of ... to the calculations ... than ... < 10 TBq into ...

... a critical value of ... the basin for its benthos is ... < 110 GBq.

... less than the permissible ... of this lake, which is ... of the water column of the

... we give a specific example ... model to the lake ecosystem.

... calculation of permissible ... into the lake.

... into the lake area of 1 km^2 ... MBq of ^{137}Cs.

... 5 m, the thickness of the layer ... — 10 cm, the sludge ... (AC) — 200 and into account ... AC of the biota, living in the ... ranges from 1 to 100000.

... what amount of radionuclides can ... the lake, so that the dose for the ... not exceed the critical limit AC

... above mentioned formula we will ... ^{137}Cs releases (Table 3).

... was performed as follows.

... consistent pattern of radionuclides ... the components of the lake ... can define the radioactivity levels in ...

... a Table of dose values or ... (Table 2), we can calculate the partial ... biota from different components of the ... for different values of AC for the ... biota.

... up the dose of the relevant columns ... we calculate the summary dose on the ... the value of the initial radionuclides ... only 1 MBq ^{137}Cs.

Then we take, for example, the summary dose in the last column, which is equal to 4,7 • 10^{-3} Gy/year when the release is 1 MBq .

And if the permissible dose to the seabed biota, as we have defined, should not exceed 4 Gy/year, then dividing the value of 4 Gy/year by the estimated value of 4,7 • 10^{-3} Gy/year we become the estimation of the quantity — Bq in permissible release, which makes — 8,5 · 108 Bq/year or 0,023 Cu/year.

Thus, it should be noted that at very high values of AC of the biota (100 000 units) annual permissible radionuclides release in the researched lake can make a very small value, only 0,023 Cu/year on only 1km^2 area of the lake.

A similar calculation was made for another biogenous radionuclide — ^{90}Sr.

It can be seen that, depending on the AC of the biota permissible releases into this lake make for ^{137}Cs from 0,023 to 2100 Cu per year, and for ^{90}Sr — from 0.1 to 7800 Cu per year, if releases take place for only one year, as it was after the Chernobyl disaster.

If it is a working nuclear power plant, it is clear that the permissible releases per year will be significantly less, so that they do not lead to exceeding the dose limits.

That is, for real values of AC for the seabed biota fairly strict limits on permissible levels of releases into such lake ecosystem can be applied.

In most cases the levels of water pollution, for which there are hygienic standards (2 Bq/L for ^{137}Cs), will be estimated as significantly smaller than the given hygienic standards.

Thus, the analysis shows that actually in this case of the lake ecosystem the ecological norm can be estimated as much tighter than the known hygienic standard.

4. Conclusions

Generally in ecology and radioecology in ecological standardization, environmental dominates such paradigm. If for human it is comfortable to live in the ecological situation, all the more nothing will damage the biota.

The analysis, which we conducted shows that this is not really so.

That is a safe situation for human can turn into high doses for the biota due to redistribution of radionuclides and high values of AC, which are peculiar to biota.

Table 3. Calculation of the dose on the components of the lake ecosystem and ...e permissible annual ^{137}Cs release depending on the values of AC for the benthos biota

...nents of the lake ...h effect the biota	K_H of the biota of benthal deposits of the lake (benthos)					
	1	10	100	1000	10000	100000
	5,4–9	5,4 –9	5,4–9	5,4–9	5,4–9	5,4–9
	3,2–8	3,2–8	3,2–8	3,2–8	3,2–8	3,2–8
...s of the lake	1,4–8	1,4–7	1,4–6	1,4–5	1,4–4	1,4–3
	3,3–8	3,3–7	3,3–6	3,3–5	3,3– 4	3,3–3
... biota	5,2–8	4,8–7	4,7–6	4,7–5	4,7–4	4,7–3
...ease into the lake:						
	7,7+13 Bq 2100 Cu	8,4+12 Bq 220 Cu	8,4+11 Bq 22 Cu	8,5+10 Bq 2,3 Cu	8,5+9 Bq 0,23 Cu	8,5+8 Bq 0,023 Cu
	2,9+14 Bq 7800 Cu	3,8+13 Bq 1020 Cu	3,9+12 Bq 105 Cu	3,9+11 Bq 10,5 Cu	3,9+10 Bq 1 Cu	3,9+9 Bq 0,1 Cu

...the lake when hygienic standards for ...can be easily fulfilled and the limits ...for the biota of the lake can be ...should be emphasized that the ...se limits on the biota of benthal ... to death of a part of the biota, and ... will lead to acidification of the ... (pH may drop to values 5–6) , ...turn can cause desorption of ...cumulated in the benthal deposits. ...mean a significant increase of water ... will also obviously exceed hygienic

...that the establishment of actually ...ical standards for Ukraine and other ...ery complicated task.

...m is that it is nearly impossible to ... ecological standards for permissible ... releases in different ecosystems.

...e. generally any ecosystem will require ...ment of a specific model and evaluation ... value of ecological standard.

...problem remains, and it is necessary to ...[...].

These same problems arise for other types of ecosystems as well.

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