Sources of Forecast of the Consequences of radiation Accidents Uncertainties

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Abstract

Epidemiological data, assessment and prognosis of dose and state of health of people' victim from Chernobyl accident have been analysed. It is demonstrated that there are two power sources of uncertainties of these forecasts: complex natural factors influence on dose from incorporated long-lived radionuclide formation and use coefficient of radiological risk unequal for condition of chromic irradiation.

Introduction

Forecast of risk (Gy^{-1}) of the negative stochastic effects (cancer, genetic disturbance) is the central problem in assessments of consequences of radiation accidents. Development of such prognosis under modern conditions unites two stages: identical estimation of dose for population, choice and use of extrapolation model for converting risk coefficient for low dose area. In real post-accidental situation in Ukraine solution of these questions is complex and polysemantic.

It is known that level and dynamics of dose are formed by character of radionuclide fallout (its scale and composition), as well as by other factors such as:

- Ecological parameters of polluted areas (type of soil, its moisture) which fix rate of inclusion of radionuclide into trophycal chains and rate of deepening of radionuclide into soil;

Social factors and economic state of country which influence on information distribution among inhabitants, scale of the national counter-measures (evacuation of the inhabitants, ban of use of contaminated areas in agriculture, their improvement and cleaning, change of character of land tenure, supply of the clean foodstuff);

National and local features of inhabitants nutrition;

Employment of the individual counter-measures (knowing of situation, wish and possibility to eat clean foodstuffs)

Interaction of these numerous factors led to the situation when estimation of doses which had been received by inhabitants of polluted regions and forecast risk of the negative stochastic effects still remain the difficult unsolved radiological problems of Ukraine. Satisfactory solution of these problems includes different approaches and points of view.

Methods and Results

Our investigation was carried out in a few steps.

I. *Estimation of "passport" dose, i.e sum of external and internal doses which may be formed under habitation in settlements with certain level of pollution and ecological characteristic.*

Estimation of internal dose for Ukrainian population is the most difficult problem. It is known that one of the results of Chernobyl accident is considerable radionuclide pollution of about 9% of agricultural area of Ukraine with different ecological characteristics, first of all with different soil types and moisture. It is known that type of soil and level of moisture are the main factors which directly determine the intensity of inclusion of radionuclide in food chains and in such a

way pollution of the food-stuffs of both plant and animal (from feed) origin. These very territories are the main source of foodstuff for several millions of people.

- In order to estimate internal component of "passport" dose the three–module ecological model of assessment of radiological consequences (EMARC) had been developed. This model has been proposed by guidelines of the National Commission of Radiation Protection and MinChernobyl of Ukraine. It is adapted for ecological and economic conditions of our country for recovery stage of radionuclide fallout [5,6]

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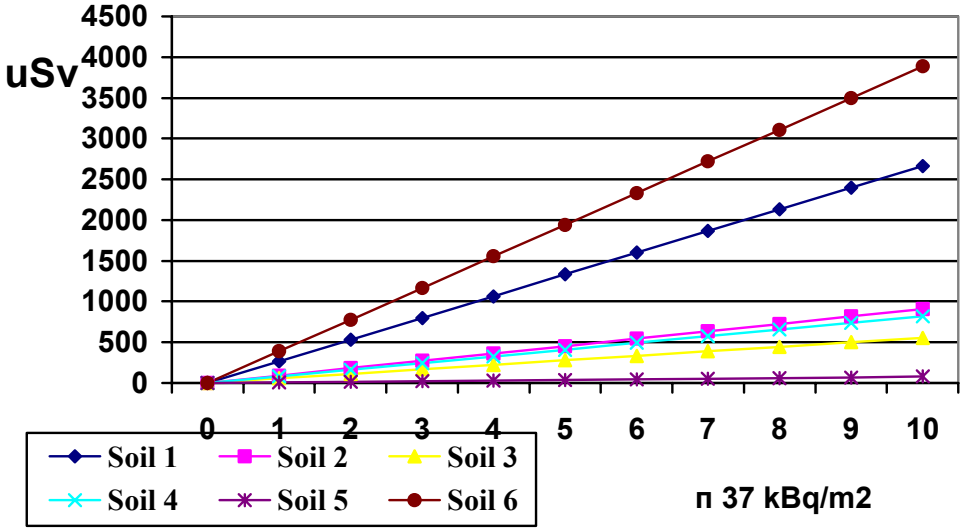
Model takes into account the main natural mechanisms of change of level of pollution of agricultural production:

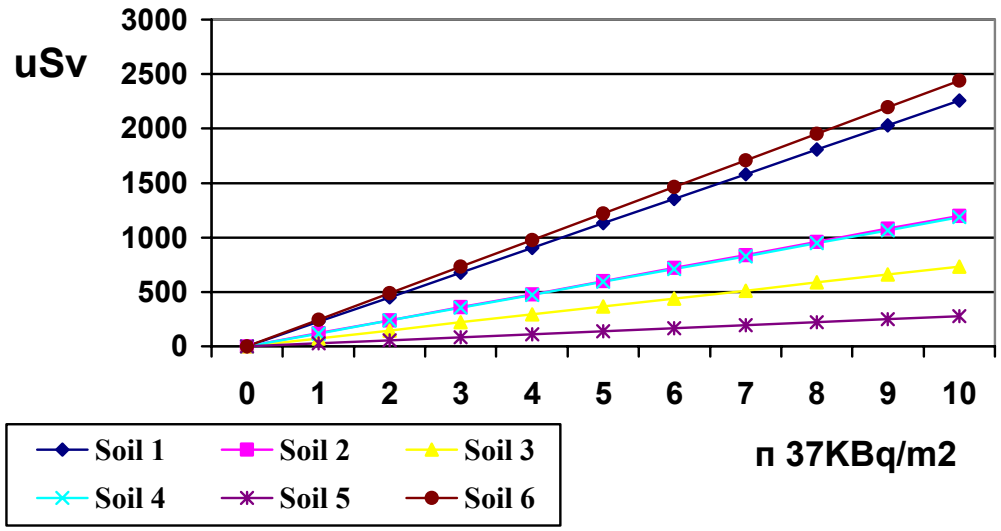
- transformation of bioavailability of radionuclide and long-term forecast of dynamics of soil-plant transfer factor;
- - features of migration ^{137}Cs and ^{90}Sr in system "soil-plant" and natural clean–up of soil;
- Inclusion and migration of radionuclide in food chains and coming in to human organisms. Estimations were conducted for agrocenosese of Northern Ukraine with six soil types. EMARC permits to perform any type of estimations of influence of environmental characteristics upon intensity of soil - plant transfer of radionuclide, pollution of food chains and internal dose formation.

This model may be used for retrospective assessment as well as for prognosis (fig 1,4).

EMARC based calculations give good coincidence with estimation performed with official "milk" model [7] for regions which have smooth seasonal dynamic of milk pollution and better coincidence with direct dose assessment for regions which have bimodal seasonal dynamic milk pollution [2,3]. Our calculations for the latter regions have good coincidence with estimation of Germany Institute of Radiohygiene (table 1).



Pic.1 Dependence of internal annual dose from ^{137}Cs on the level of pollution and type of soil.



Pic 2. Dependence of internal "life –time dose" from ^{90}Sr on the level of pollution and type of soil.

(1 soil**)** sod-podzolic sandy loam; **(2)**-sod-podzolic weakly gleyed, **(3)**- sod-podzolic heavy gleyed, **(4)**- gray forest , **(5)** black (chernozyom) and **(6)** -turfary.

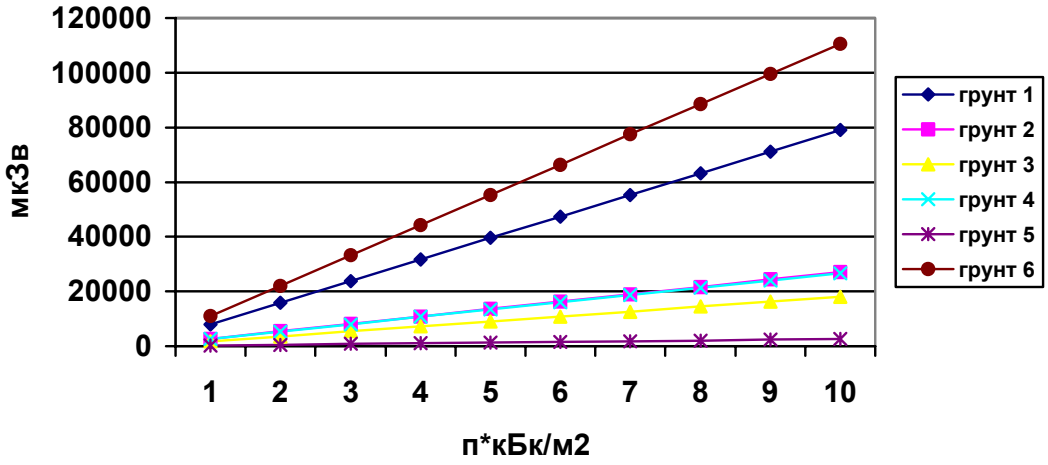


Figure 3 Dependence of internal "life –time dose" from ^{137}Cs on the level of pollution and type of soil.

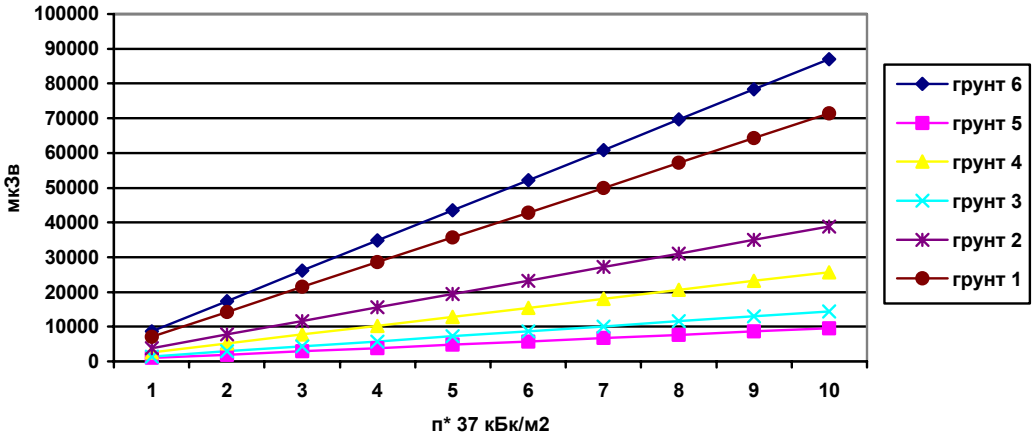


Figure 4 Dependence of internal "life –time dose" from ^{90}Sr on the level of pollution and type of soil.

1 soil**)** sod-podzolic sandy loam; (**2**)-sod-podzolic weakly gleyed, (**3**)- sod-podzolic heavy gleyed, (**4**)- gray forest , (**5**) black (chernozyom) and (**6**) -turfary.

Table 1

Comparisons of the calculations with use different methods

Settlements	Direct and indirect methods of dose estimation (mSv)					
	Reseach Centre for Radiation Medicine, Ukraine		**Germany Institute of Radiohygiene**		**EMARC**	
Luginsky rigion, Zhitomir district	**1991**	**10 years**	**1991**	**10 years**	**1991**	**10 years**
	0,94-1,9	17-35	-	-	0.6-1.9	5,3-17,7
Rovno district	-	-	2.3	104	3.2	120

II. Choice the extrapolation model for risk assessment for area of low dose and prognosis development.

These estimations were performed according to the programme "Granit" of the President of Ukraine.

We approved two extrapolation models of risk assessment: linear dependence of "cancer risk-dose" and model Petke [4] that additionally takes into account rate of dose.

Calculations were performed in two steps: the first was realised risk estimation (that is per realised 15-year-dose), then development of risk prognosis per "life-time dose". The first step of calculation was needed to compare theoretical estimation and the real data of the Ukrainian Chernobyl register. Calculations of realised risk have demonstrated that significant increase of cancer cases for population of polluted regions is absent. This conclusion coincided with data of National register according to which for population the rate of increase of cancer is in interval 4 - 12% a year that is the same as for other regions of Ukraine [1].

Forecast of "life-time risk" does not exclude conservation this general tendency.
At the same time such way of prognosis of radiation cancer, may have no prospects: dynamics of manifestation of different cancer forms under conditions of chronic irradiation may differ substantially from such dynamics under conditions of at-once exposure.

References

1. Epidemiological investigation, assessment and prognosis of state of health of persons victim from Chernobyl accident. Final scientific report.,2001 p, 198 c.
2. Garner N. A mathematical analysis of the transfer of fission products to cows milk // Health Physics.-1967.- v.13, N1.- P. 205-212
3. "Integrated analysis of radiation situation and optimization of utilization of agrocenosese of radioactive polluted territories. Data of regional radiobiological subsection"// Final scientific report – (Contract № 14/60H-99), 2002, 109 P.(in Ukrainean)
4. Korblein A. Cancer mortality and background level of radiation in Bavaria// Low doses. Materials of permanent functioning seminar.-Minsk, Republic of Belarus,2001,p198
5. Kravets A.,Pavlenko Yu.A., Grodzinsky D.M. Soil-plant linkage and expected doses in human resulted from incorporated long-lived radionuclide// Rad.biol.ecol. 36 :9-16; 1996 (in Russian)
6. Kravets A.P,.Grodzinsky D.M, Pavlenko Yu.A. Radioecological assessment of radiological consequences of polluted agrocenosese use //Scientific papers of the Institute for nuclear research,N 3(5), 2001,141-152
7. Likhtarev I.A., Kovgan L.N., Vavilov S.E., Gluvchinsky R.R., Perevoznikov O.N., Litvinets L.N., Anspaugh Lynn R., Kercher J.R., Bouville A.Internal exposure from food contaminated after the Chernobyl accident// Health Physics.- 1996.- v.70, N3. - P. 298-310