Phil Risbeck, USA, 2011

Long-term External Dose Formation in the Chornobyl Exclusion Zone

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РАДА

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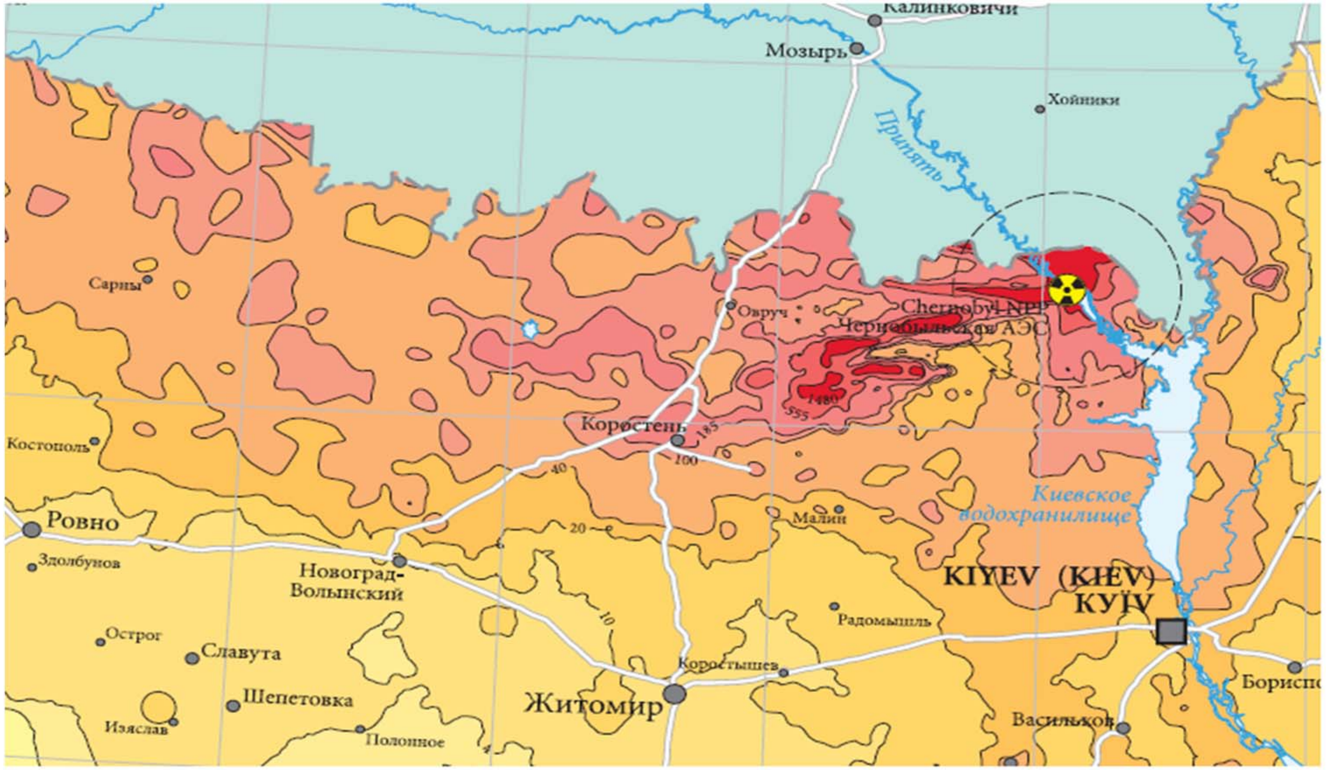
AUTOMATED RADIATION MONITORING SYSTEM

- In December 1988 an automated radiation monitoring system (ARMS) was put into pilot operation in the Chornobyl exclusion zone by the Office of Dosimetric Control of the Scientific and Industrial Association "Prypyat". The system was designed on a basis on three sets of radiation reconnaissance "Tuna", which Soviet military used in the times of nuclear testing. Until recently, the old ARMS was in operation in the State Specialised Scientific and Industrial Enterprise "Chornobyl Radioecological Centre".

- In June 2008, replacing the old ARMS, a new modern ARMS was put into pilot operation under a project of international technical assistance TACIS U4.01/03S to support Ukraine's efforts to overcome the consequences of the Chornobyl accident. 28 sensors with cable communications, which were located in different places and at different sites of the Chornobyl exclusion zone, including Slavutych city, were replaced by 39 sensors of new generation with communications by radio channel. The old system worked one year more in parallel with the new system, and then was transferred to a backup mode for a case of unexpected failure of the new system.

- The old ARMS left a legacy of unsurpassed 20 years spatial-temporal series of exposure dose rate observations in the Chornobyl exclusion zone. This publication is devoted to analysis of these series and some related conclusions.

Contamination of the Northern Ukraine by ^{134}Cs and ^{137}Cs after the Chornobyl accident



Isolines are marked in kBq m[2]. Atlas of radioactive contamination of Europe after the Chornobyl accident. European Commission. 1998. Luxembourg, ISBN-92-828-3140-X.

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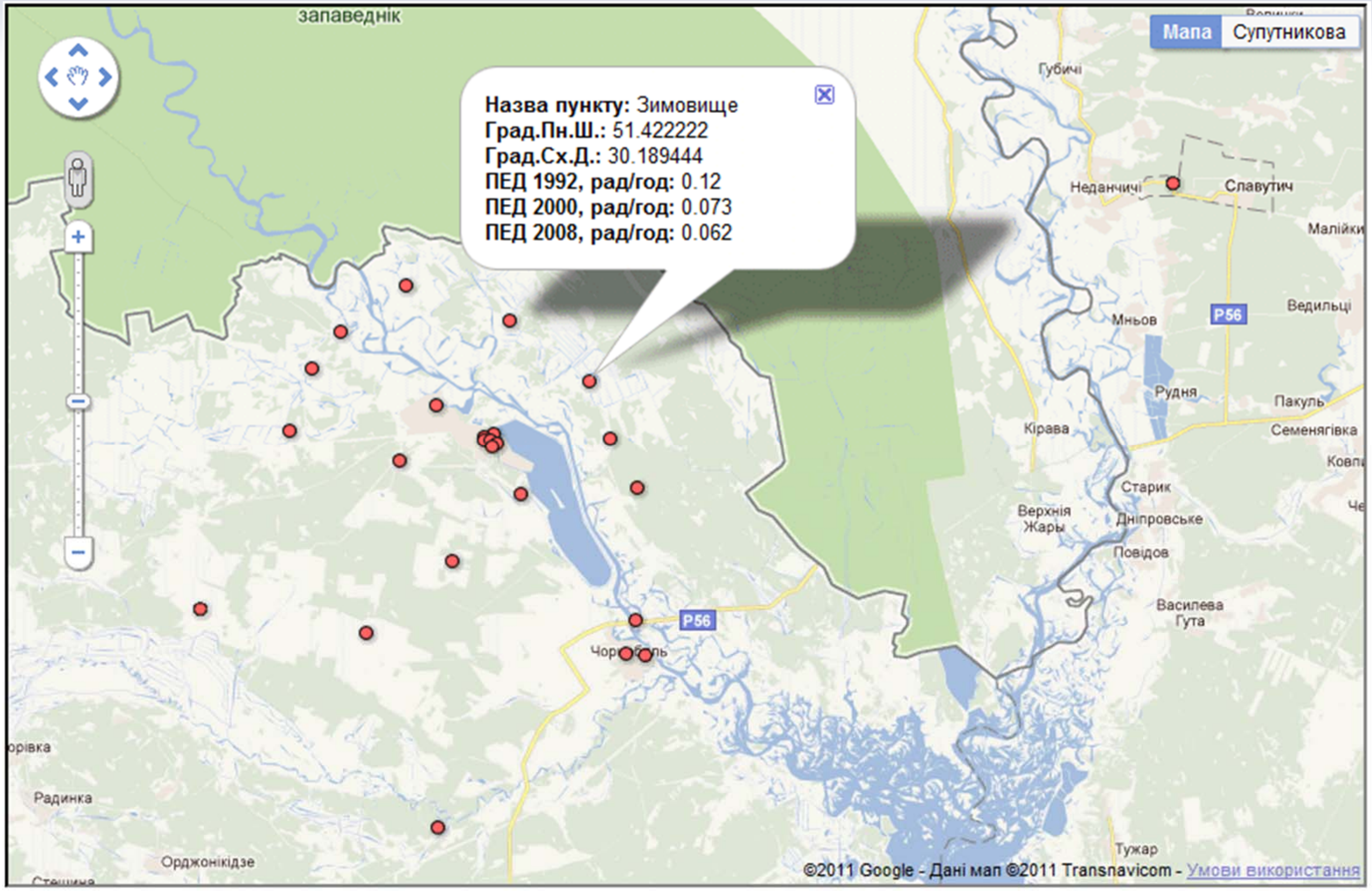
LOCATION OF THE OLD ARMS



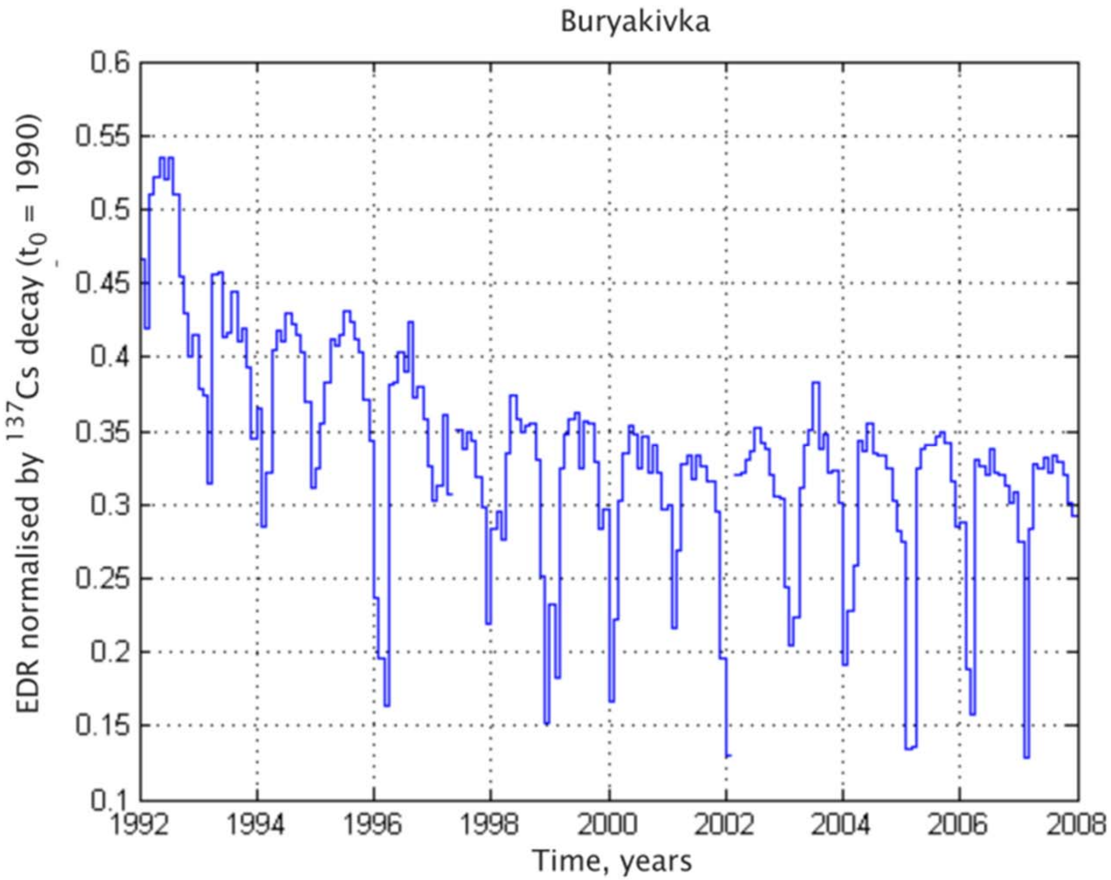
Blogger, URPS Blog, September 8, 2010, URL http://urps-notices.blogspot.com/2010/09/blog-post.html

Long-term dose rate dynamics

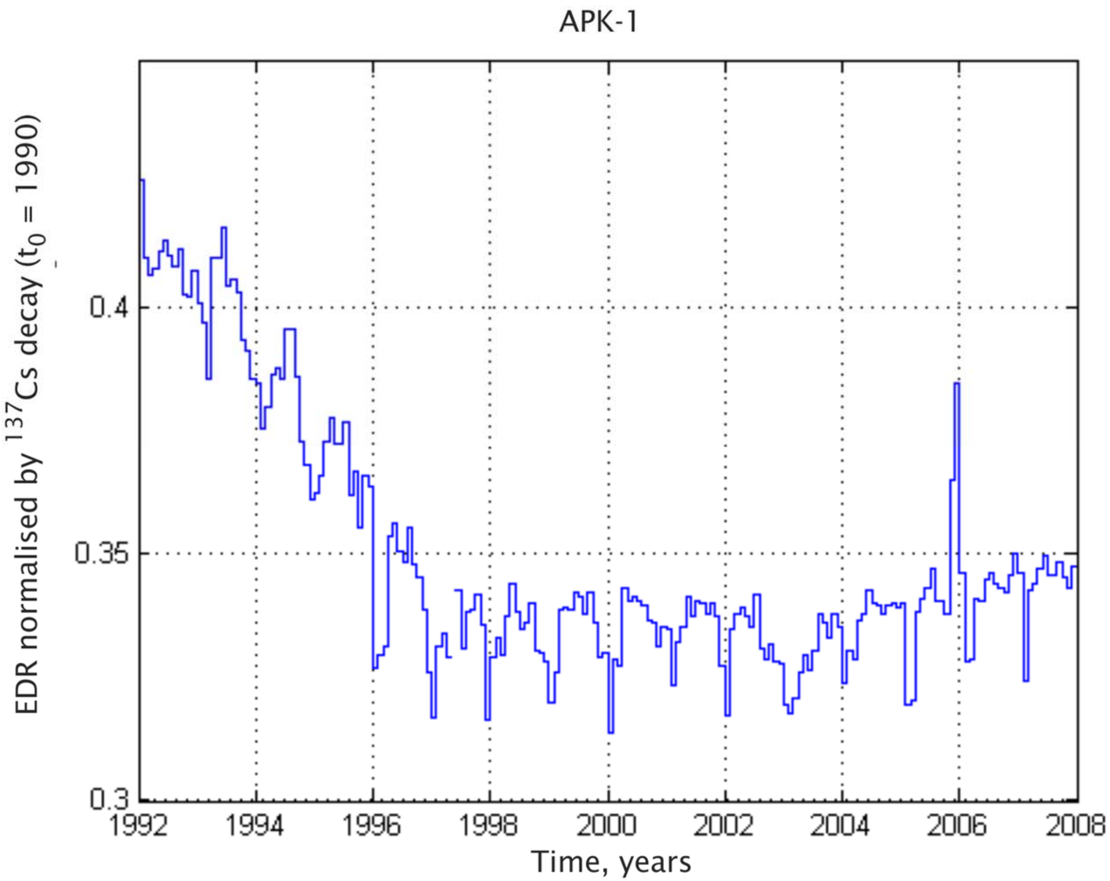
- Half-life time of ^{137}Cs - 30.17 y
- Dose rate reduction due to deepening in soil:
  - **8% y^{-1} or 8.3 y half-life time**
    (H. Yonehara, *et. al*. Proc. of 10th Intern. Congress, May 14-19, 2000 at Hiroshima, Japan. Ref. No. P-11-259)
  - **4.1% y^{-1} or 16.2 half-life time**
    (Reconstruction and forecast of public exposure at the territory of Ukraine contaminated as a result of the Chornobyl accident. (Instruction) SCRM of AMS of Ukraine. Edited by Prof. I.A. Lyhtarev. K., 1998.)
  - In the period 1992-2008 the dose reduction for these models would make **50% – 75% or 2 – 4 times**.
- In order to compensate ^{137}Cs decay all the data series of ARMS are to be multiplied by (or normalised):

$$e^{\ln 2 (T - T_0)/T_{1/2}}$$

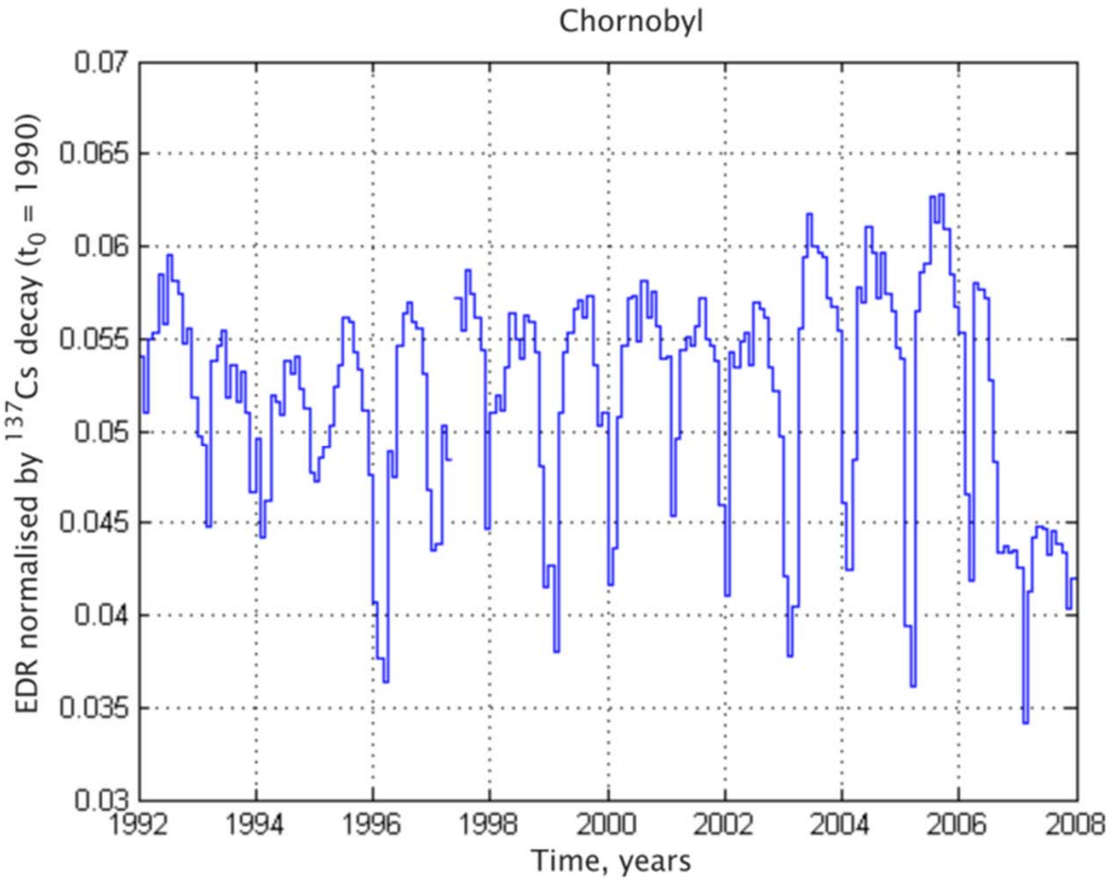
Normalised dose rate at point Buryakivka



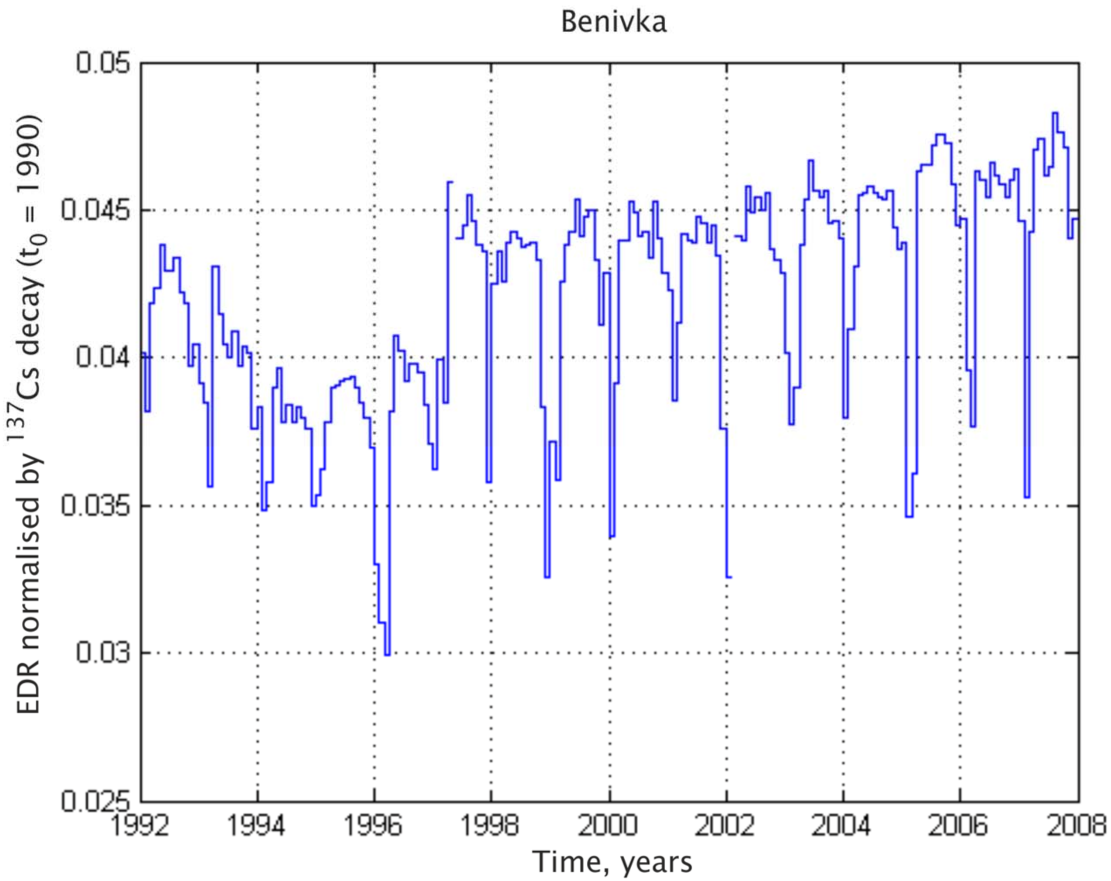
NORMALISED DOSE RATE AT POINT APK-1



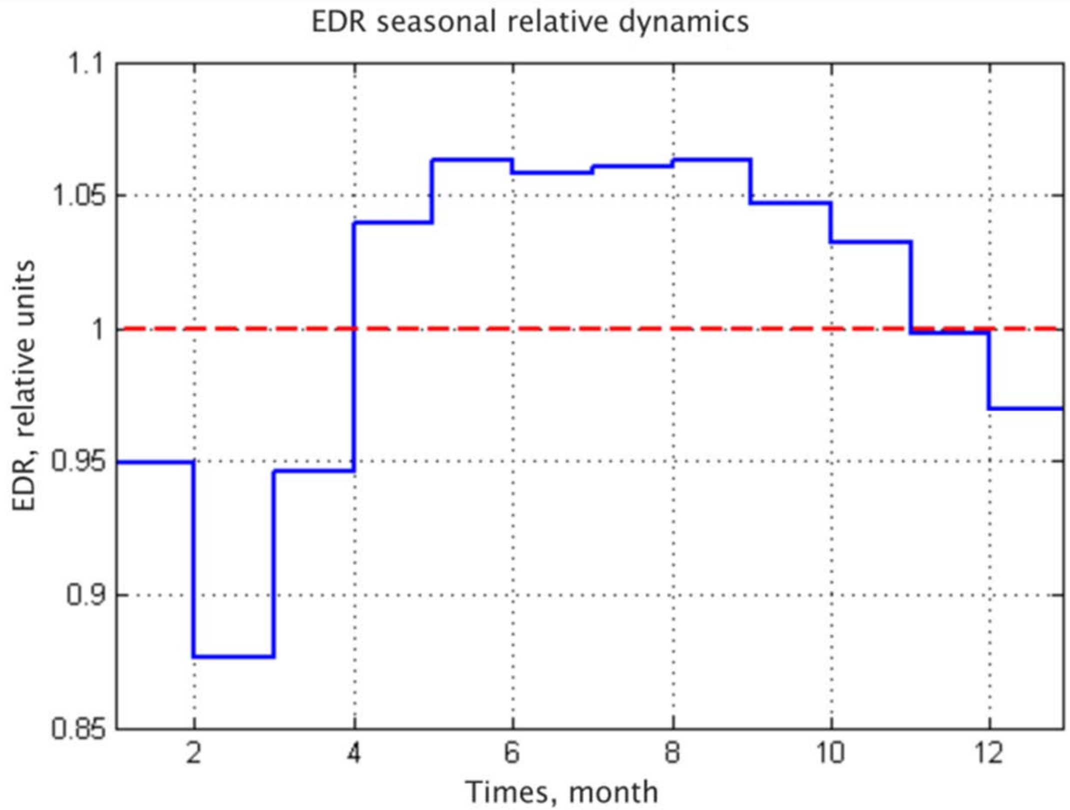
Normalised dose rate at point Chornobyl



NORMALISED DOSE RATE AT POINT BENIVKA

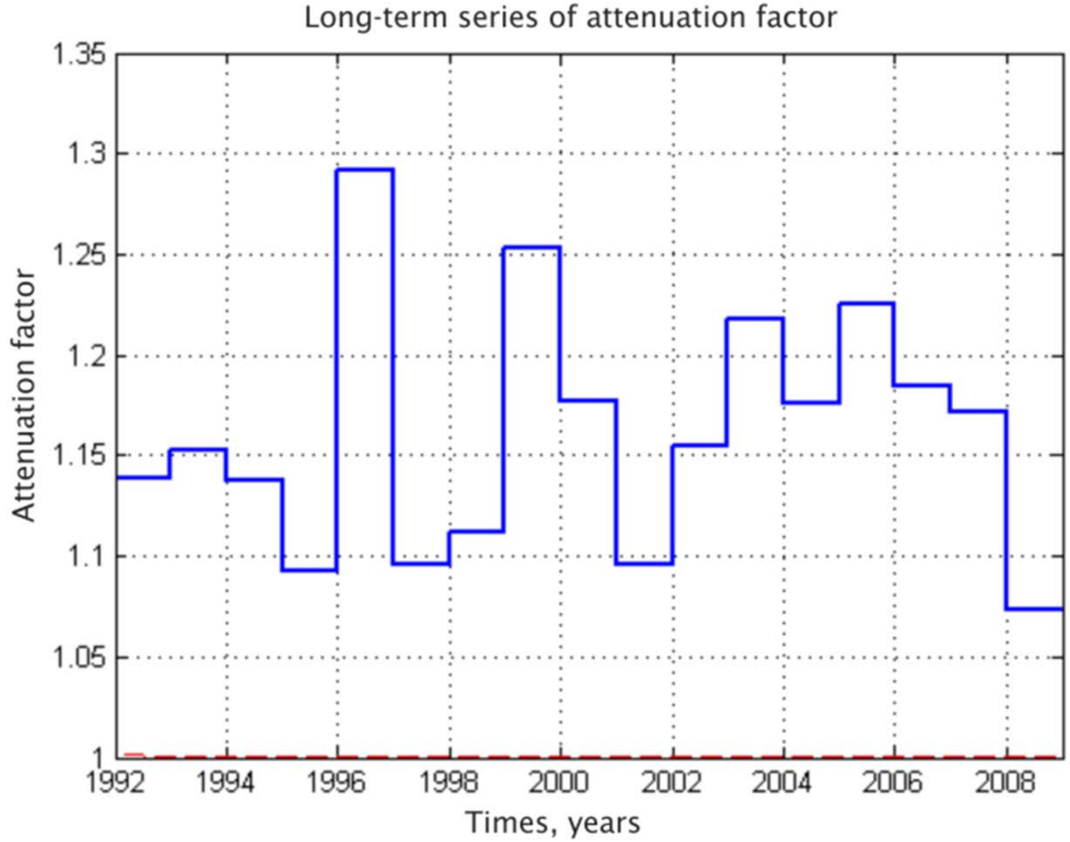


Dose rate seasonal variation



Monthly median values of the relative EDR

Long-term EDR ratio "summer-winter"



Ratio of average EDR in May-September and in December-March

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Research of external exposure to the people living at the Chornobyl exclusion zone

- State enterprise "RADEK“ and JAERI within framework of international cooperation in 1995-98 were carried out measurements of the equivalent dose of gamma exposure in settlements in the vicinity of Chornobyl.
- It should be noted here that according to the Law of Ukraine, entered into force in 1991, it is prohibited for the people to live in the Chornobyl exclusion zone. However, before 1991 a part of the evacuated people (about 1500, mostly elderly ones) returned to their homes located in the Chornobyl exclusion zone. Currently (in 2011) their number is below 300.

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METHOD AND OBJECTIVE OF THE RESEARCH

- Within framework of the aforementioned research in 1997-1998 every participated local inhabitant of the contaminated territories received **three** Toshiba dosimeters for a certain period of time (between 1 and 3 months).
- One of the dosimeters was borne by a participant pinned onto his/her outer clothing, another one was kept in home, and the third one was fastened to a stick that put into participant's yard.
- After all the results were collected three values were obtained, i.e. the individual external dose E_{ind}, the home dose E_{home} and the outdoor dose E_{out}.

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Results of the research

- In total **273** people from **23** settlements took part in research during 1997-1998.
- The minimal value of the individual dose was found **603 μSv·year^{-1}** and the maximal one – **18.3 mSv·year^{-1}** (Ragivka, 2.06 mSv in 41 days). The minimal outdoor dose was found **678 μSv·year^{-1}** and the maximal one – **7.71 mSv·year^{-1}**.

INDIVIDUAL DOSE VERSA THE DENSITY OF ^{137}Cs SURFACE CONTAMINATION

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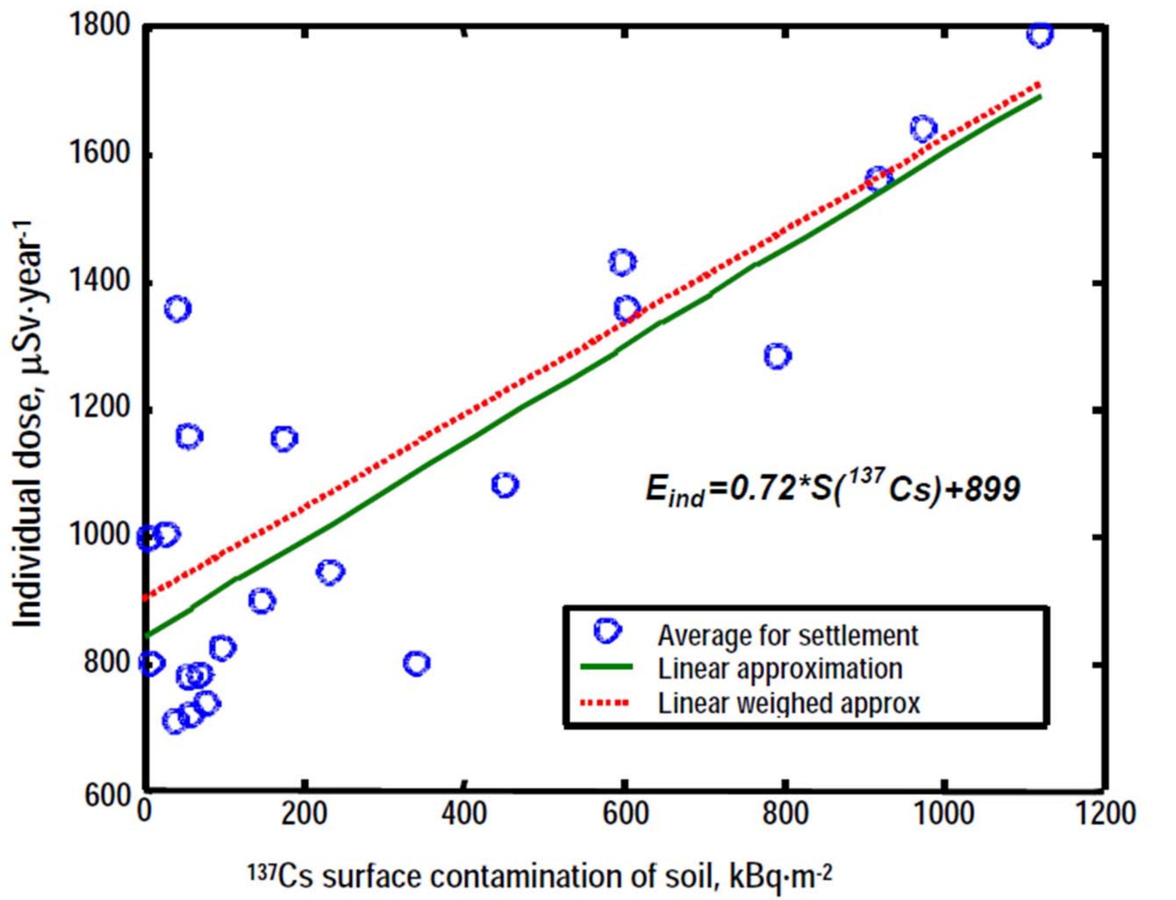

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SUMMARY

- Attenuation factor *R*(*T*) of the equivalent dose rate from ^{134}Cs and ^{137}Cs due to deepening in soil used for dosimetric certification of Ukraine, requires parametric adjustment. At the first approximation for the late stage of the Chornobyl accident and for the prospect of the next 10-20 years the attenuation factor *R*(*T*) can be taken equal 1. Although such a conclusion would require further research.
- On average the seasonal deviation of EDR due to atmospheric precipitation has been reaching 20%, although particular monthly average values may deviate as twice in one or other side out the average value.
- The dose conversion factor from the density of ^{137}Cs surface contamination to the individual annual dose was determined about 0.7 $\mu Sv \cdot year^{-1}/(kBq \cdot m^{-2})$ for rural conditions. Also, a contribution from natural radioactivity sources to the individual dose was determined at level 0.9 $mSv \cdot year^{-1}$.
- The reliability of individual dose assessment for the people living at highly inhomogeneous contamination of the territory is maintained by the safety factor. The safety factor obtained in the study for the Chornobyl exclusion zone made of 3.
- Three kinds of localisation of dosimeters in this study makes possible to calculate the shielding factor - 4.8, and the behaviour factor - 0.39.

Thank you very much!