

**Radioecological vulnerability assessment
and guideline levels for
terrestrial foodchain**

PhD theses
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Background

Radionuclides in the environment produce dose to human and biota. Legislation for radioactivity content of food and feedstuffs is based on the limiting of additional dose above the background level. The establishment of derivation of guideline level system involves the model-developments. Goals of the radioecological modelling are the following:

- description of the state of the environment, characterisation of the ecosystem,
- prediction of the behaviour of the radionuclides in the environment and behaviour of the element of the environment following the release of the radionuclides,
- follow the changes in the ecosystem, developing and maintaining the monitoring programs, planning of the remediation work.

Observation, measurement, experiment, practice, theoretical considerations and mathematical description are equally needed to develop an effective, well established system.

Goals

After thoroughly studying the legislation for radioisotope content of food and feedstuffs regarding the European and international regulations I feel it necessary to extend them with a guideline level system applicable in normal circumstances and prolonged emergency situation, when there is any economical restriction. Legislation in force in European Union is a follow up type now and deals with only the periods after emergency or contains indirect dose limit for the population. I would like to provide the scientific base of the regulation of radioactivity content of food and feed connected with each other.

Above all the primary goal of agricultural production is providing safe and enjoyable food for the whole population of the World. My goal is to provide the scientific base of the implementation a regulation which gives the right to just one authority dealing with the foodstuffs for the sake of the effectiveness of the necessary measures, the immediate withdrawal of the foodstuffs or feedstuffs in case of non-compliance. Applying the individual limits for each radionuclide is the appropriate solution without grouping them to take into consideration their different physical and absorption properties which is feasible in the recent level of the measurements and informatics.

The monitoring program intended to control effectively the food provision and agricultural production has to take into account the vulnerable areas, transport processes of the foodchain, consumption habits in normal circumstances. The other base of planning the countrywide monitoring program is the study of radioecology and finding the critical vulnerable points in the foodchain.

New scientific results:

- 1 thesis: I elaborated the guideline level system for regulating the radioactive isotope content of food and feedstuff, which takes into account the all possible sources, among them releases from the nuclear installations both during the normal operation and accidental situations. I recommend the application of the age-independent tolerance level based on the risk of 5×10^{-6} in normal circumstances. In case of prolonged emergency situation (longer than one year) the acceptable levels are applicable for two age groups (children below one year and adults) based on the additional dose of 1 mSv/year. Decision limits were defined for each levels depending on the measurement combined standard uncertainty. In case of more radioisotope found in the food or feedstuff the addition rule has to be applied.
2. thesis: The radionuclide content of food and feedstuffs has to be regulated connected with each other. Derivation of the acceptance level for feed from the acceptance level of food of animal origin gives stricter regulation, than the recommended dose levels for biota. The difference between the dose of animal via ingestion of the feed of the acceptance level is two order of magnitude less than the suggested dose limit of biota, therefore there is no need of other justification like addition rule or tolerance level, this difference is the guarantee of the proper protection of animals too.
3. thesis: The regulations for foodstuffs and feedingstuffs are based on additional dose from all possible sources above the background level, therefore I appointed the upper level of background level for foodstuffs and feedingstuffs, taking into account the monitoring results of the term following at least twenty years of accidental release free period. The upper level of the background was defined for artificial radionuclides

according to lognormal distribution and for natural radioisotopes according to normal distribution. The activity concentration above this level requires investigation. During the evaluation of the monitoring dataset of the network it is essential to have a clear idea of the uncertainties attributed to the measurements of the detection of an isotope in a network level [1, 2].

4. thesis: For the long term effect of the releases on the agricultural production the radioecological vulnerability criteria were appointed. ^{90}Sr transfer between soil and plant gives an appropriate discrimination for the vulnerable agricultural areas. The absorption of ^{137}Cs in the animals gives the most vulnerable point of the feed and animal transfer. The isotope ratio of $^{241}\text{Pu}/^{239+240}\text{Pu}$ gives information even at low concentration levels whether the contamination came from nuclear installation, which can determine the emphasis of further survey. Among the analogues the correlation between ^{210}Pb and ^{137}Cs gives information for the ratio of resuspension of artificial isotope among the root uptake and fresh fall-out [3, 4, 5, 6, 7].
5. thesis: For the managing the countrywide network dealing with the control of foodstuff and agricultural production the following criteria has to be kept in mind:
 - there is a need of the independent control from any economical organisation and interest, because the food supply for public and the agricultural production is strategic question; only the governmental control is acceptable taking into account the need of the society;
 - the location of the laboratories has to be taken account the total coverage of the country, no problems could be arised from the sample-transport or providing the result even in emergency situation;

- keeping the economic efficiency and high quality of work in sight the control of the radioactivity has to be based on the infrastructure of general food control system, the monitoring schedule has to be issued for controlling the inland production, export and import products;
- the yearly revised monitoring program has to contain above the controlling the foodstuffs, samples giving information of the agricultural environment among them the forest and wild animal management, stationary elements for providing the long term tendencies and the same time it is essential to give floor for the changes in the field of production and consumption habits;
- harmonisation of analytical work and the quality assurance system is essential;
- the rapid methods applicable in emergency situation has to be kept in everyday use beside the nuclide selective measurement techniques providing more accurate results and better minimum detectable activity concentrations;
- keeping of the staff well-trained is important, with courses, intercomparisons and proficiency tests [8, 9].

Scientific papers in connection with theses

- [1] B. Varga, S. Tarján: Reporting of Uncertainty in Environmental Monitoring of Radionuclides, Combining and Reporting Analytical Results, Eds A. Fajgelj, M. Belli, U. Sansone, The Royal Society of Chemistry, ISBN: 0854048480, ISBN-13:9780854048489, Cambridge, (2007) 195-204.
- [2] Tarján S, Varga B, Sebestyén T: A ²²²Rn minőségbiztosítási szemszögből, III. Magyar Radon Fórum, ISBN 963 6420 99 8, Veszprém (2006) 51-57.
- [3] B. Varga, S. Tarján: Determination of ²⁴¹Pu in environmental samples, Applied Radiation and Isotopes 66 (2008), 265-270.
- [4] B Varga, S Tarján, N Vajda: Plutonium isotopes in the Hungarian environment, Journal of Environmental Radioactivity 99 (2008) 641-648.
- [5] B. Varga, E Leclerc, P. Zagvyai: The role of analogues in radioecology, Journal of Environmental Radioactivity folyóiratba beadott
- [6] IAEA TECDOC: Handbook of parameter values for the prediction of radionuclide transfer to humans in terrestrial and freshwater environments – megjelenés alatt
2. Definitions, data analysis and use of analogues
2.1. Definitions and units - S.Fesenko, N.Sanzharova, M.Vidal, A.Shubina, Y.Thiry, E. Reed, B. Varga
2.4. Use of analogues - E. Leclerc, K. Tagami, S. Uchida, B. Varga
- [7] IAEA Technical Report Series 364 amendment in preparation - Handbook of parameter values for the prediction of radionuclide transfer in temperate environments – contributor – megjelenés alatt
- [8] B. Varga, S. Tarján, M. Süth, B. Sas: Radionuclide Monitoring Strategy for Food-Chain in Hungary, Journal of Environmental Radioactivity, 86 (2006) 1-11.
- [9] Varga B, Ádámné S.T., Tarján S: Radioaktív izotópok a táplálékláncban, Környezeti ártalmak és a légzőrendszer XVI. Kötet 2006. ISBN-10: 96387327-0-9, Zalaegerszeg, (2006) 227-232.