National Institute for Public Health
and the Environment
Ministry of Health, Welfare and Sport

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Milk, Food and Feed – results 2019

RIVM letter report 2021-0080
C.P. Tanzi | G.J. Knetsch

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Nederlandse Voedsel en Waren Autoriteit (NVWA)
Data on foodstuffs.
E. Laurensse

WAGENINGEN
UNIVERSITY & RESEARCH

Wageningen Food Safety Research (WFSR)
Data on milk and foodstuffs.
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Synopsis

Monitoring of radioactivity in the Netherlands
Milk, Food and Feed – results 2019

In 2019, the Netherlands fulfilled its annual European obligation to measure how much radioactivity is present in the environment and in food. Radioactivity levels in food and milk were below the European export and consumption limits. The radioactivity levels in grass and feed were normal, as in previous years.

All countries of the European Union are required to perform these measurements each year under the terms of the Euratom Treaty of 1957. The Netherlands performs these measurements following the guidance issued in 2000. The measurements represent the background values for radioactivity that are present under normal circumstances. They can be used as reference values, for instance, during a nuclear emergency. The results on radioactivity in the environment are reported to the European Commission by the National Institute for Public Health and the Environment (RIVM) on behalf of the competent authority in the Netherlands.

Keywords: radioactivity, milk, food, feed

Publiekssamenvatting

Monitoring van radioactiviteit in Nederland
Melk, voedsel en veevoer – resultaten 2019

In 2019 voldeed Nederland aan de Europese verplichting om elk jaar te meten hoeveel radioactiviteit in het milieu en in voeding zit. De radioactiviteitsniveaus in voedsel en melk liggen net als in vorige jaren onder de Europese limieten voor consumptie en export. De radioactiviteitsniveaus in gras en veevoer laten een normaal beeld zien, net als de jaren ervoor.

Alle landen van de Europese Unie zijn volgens het Euratom-verdrag uit 1957 verplicht om deze metingen te doen. Nederland volgt daarbij de aanbevelingen uit 2000 op om de metingen op een bepaalde manier uit te voeren. De metingen leveren achtergrondwaarden op, ofwel radioactiviteitsniveaus die er onder normale omstandigheden zijn. Deze waarden kunnen bij bijvoorbeeld calamiteiten of rampen als referentie dienen. Het RIVM brengt namens Nederland verslag uit aan de Europese Unie over radioactiviteit in het milieu.

Kernwoorden: radioactiviteit, melk, voedsel, veevoer

Contents

Summary

Radioactivity was measured in 756 cow's and 17 goat's milk samples and in more than 2300 food products. Of these food products, 20 samples of game and 12 samples of fresh mushrooms (mushrooms originating from Bosnia and Herzegovina, Belarus and Turkey) contained ^{137}Cs above the detection level of 5 Bq·kg^{-1}. The activity concentration of game varied from 5 to 61 Bq·kg^{-1}. The activity concentration of mushrooms varied from 7 up to 163 Bq·kg^{-1}. The limits for radiocesium (sum of ^{134}Cs and ^{137}Cs) in food (600 Bq·kg^{-1}) and in milk and dairy products (370 Bq·kg^{-1}) were not exceeded.

The measured activity concentrations of ^{90}Sr, ^{134}Cs and ^{137}Cs in food in Bq·kg^{-1} were converted to an average daily intake value per person per day (Bq·day^{-1}) using food consumption patterns. The average daily intake per person of ^{134}Cs, ^{137}Cs and ^{90}Sr is < 5 Bq·day^{-1}, for each of the nuclides separately. The contribution to the effective yearly dose calculated from these average daily intake values is < 0.12 mSv. The actual daily intake of ^{134}Cs, ^{137}Cs and ^{90}Sr (and following dose contribution) is most likely much lower.

None of the grass and feed samples contained measurable levels of artificial radionuclides (^{60}Co, ^{131}I, ^{132}Te, ^{134}Cs and ^{137}Cs).

1 Milk

Wageningen Food Safety Research monitors radioactivity in milk on a weekly basis, mainly via the National Monitoring Network of Radioactivity in Food (Landelijk Meetnet Radioactiviteit in Voedsel, LMRV). The LMRV has been set up as an emergency network for monitoring relatively high contamination levels in case of an accident. The LMRV consists of 50 low-resolution γ spectrometers (NaI-detectors) located throughout the Netherlands, 23 of which are located at dairy factories.
The results of the weekly samples of cow's milk taken from all locations are combined into a monthly average for the whole country. The monthly averages for 2019 are presented in Table 1. Figure 1 shows the spatial variation of the yearly average ^{40}K concentrations per region and the distribution of the sampling locations across the Netherlands.

Table 1 Monthly average activity concentrations (Bq·kg^{-1}) in cow's milk in 2019.

Month	No. of samples	^{40}K (1)	^{60}Co (2)	^{131}I (2)	^{134}Cs (2)	^{137}Cs (2)
January	65	56.1 ± 11.5	< 1.4	< 0.6	< 0.6	< 0.5
February	57	53.4 ± 12.9	< 1.4	< 0.6	< 0.6	< 0.5
March	51	51.3 ± 11.1	< 1.4	< 0.6	< 0.6	< 0.5
April	64	53.0 ± 11.5	< 1.4	< 0.6	< 0.6	< 0.5
May	62	54.8 ± 9.6	< 1.4	< 0.6	< 0.6	< 0.5
June	58	55.1 ± 11.1	< 1.4	< 0.6	< 0.6	< 0.5
July	72	53.7 ± 9.0	< 1.4	< 0.6	< 0.6	< 0.5
August	58	53.9 ± 11	< 1.4	< 0.6	< 0.6	< 0.5
September	51	52.0 ± 9.1	< 1.4	< 0.6	< 0.6	< 0.5
October	65	53.4 ± 11.7	< 1.4	< 0.6	< 0.6	< 0.5
November	54	53.9 ± 11.5	< 1.4	< 0.6	< 0.6	< 0.5
December	52	53.2 ± 12.9	< 1.4	< 0.6	< 0.6	< 0.5
Average	**709 (3)**	**53.7 ± 11.1**	**< 1.4**	**< 0.6**	**< 0.6**	**< 0.5**

(1) Standard deviation is given as 1σ.
(2) Calculated minimal detectable activity concentrations for the respective radionuclides, based on 1 litre Marinelli beaker measurements on the Food Monitor Systems.
(3) Yearly total.

No anthropogenic γ-emitters were measured above the minimal detectable activity in any of the samples, as is shown in Table 1, so the limit of 370 Bq·kg^{-1} for the radiocesium activity (sum of ^{134}Cs and ^{137}Cs) set by the European Union [1,2] was not exceeded. The activity concentration of the natural radionuclide ^{40}K is given as a reference value. The yearly average concentration was 53.7 ± 11.1 Bq·kg^{-1}. This value is within the range of those found in previous years.

[1] EC, 2009. Council Regulation on the conditions governing imports of agricultural products originating in third countries following the accident at the Chernobyl nuclear power station. EC Brussels, No. 1048/2009.
[2] EC, 2008. Council Regulation on the conditions governing imports of agricultural products originating in third countries following the accident at the Chernobyl nuclear power station. EC Brussels, No. 733/2008.

Additionally, 11 goat's milk samples were analysed. As in cow's milk, anthropogenic γ-emitters were not measured above the minimal detectable activity. The yearly average ^{40}K concentration in these samples was 66.0 ± 11.2 $Bq{\cdot}kg^{-1}$. This value is within the range of those found from 2014 to 2018.

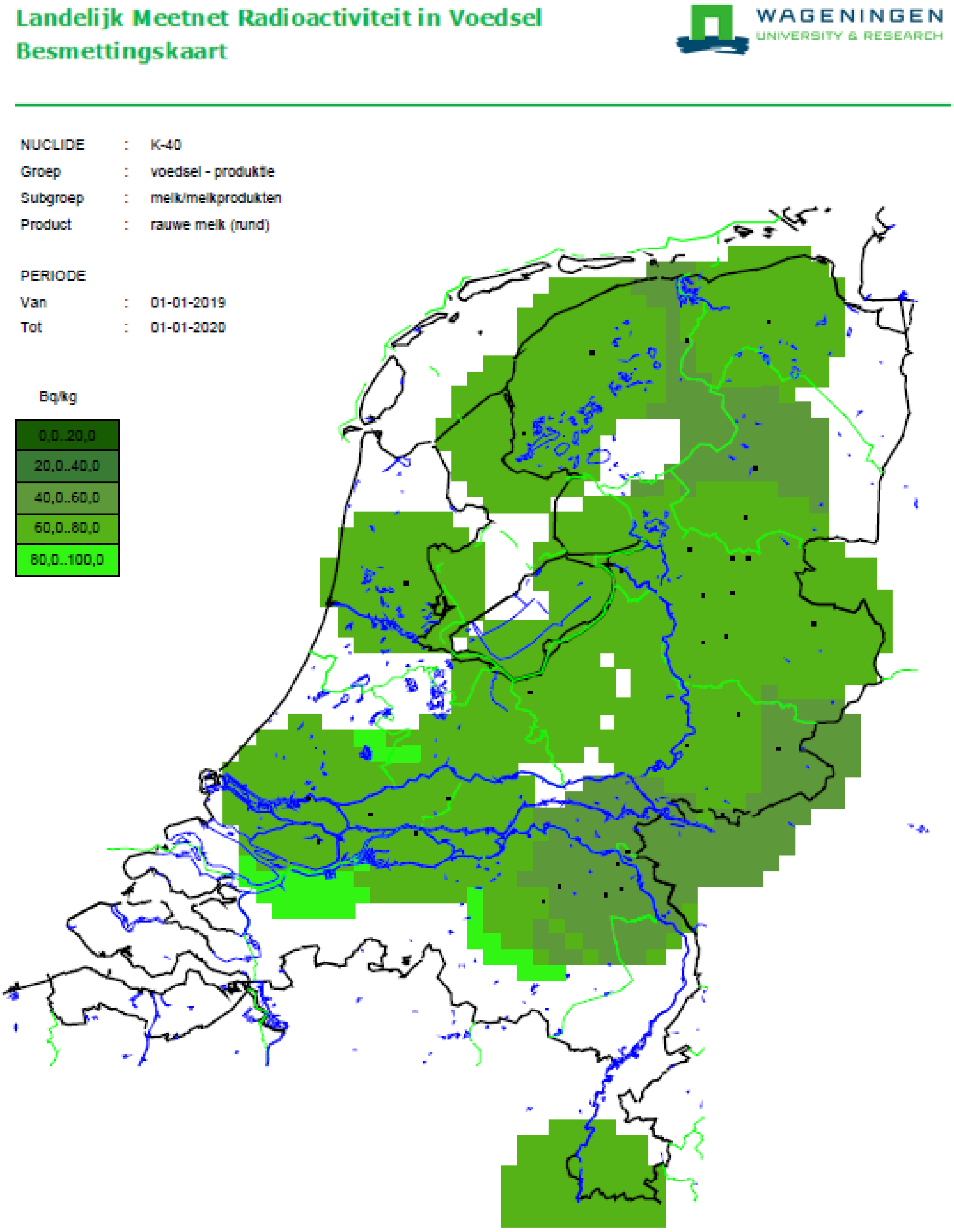
In addition to the LMRV samples, 53 milk samples (47 cow's milk and 6 goat's milk samples) were analysed for a range of γ-emitters on a high-resolution gamma spectrometer in the WFSR laboratory in Wageningen. The samples were collected across the Netherlands. None of the samples showed any anthropogenic gamma activity above the minimal detectable activity (<1 $Bq{\cdot}kg^{-1}$ for ^{137}Cs in 0.5 L Marinelli beakers). The average concentration found for the natural radionuclide ^{40}K in the 47 cow's milk samples was 44.6 ± 6.7 $Bq{\cdot}kg^{-1}$; for the 6 goat's milk samples the average was 52.9 ± 7.6 $Bq{\cdot}kg^{-1}$ see Table 3.

The same 53 raw milk samples were analysed for the presence of the β-emitter ^{90}Sr using low-level liquid scintillation counting (LSC), see Table 4.

The ^{90}Sr activity concentration was below the minimal detectable activity (0.2 $Bq{\cdot}kg^{-1}$) in all samples taken, so none of the samples exceeded the set limit of 125 $Bq{\cdot}kg^{-1}$ used in new emergency exposure situations [3]. No limit for ^{90}Sr has been set for existing exposure situations as defined in [4].

WFSR also monitors raw milk specifically for export certification. For this, samples were analysed for ^{137}Cs and ^{90}Sr. All results were below minimum detectable activities as well.

[3] Council Regulation (Euratom) 2016/52 of 15 January 2016 laying down maximum permitted levels of radioactive contamination of food and feed following a nuclear accident or any other case of radiological emergency, and repealing Regulation (Euratom) No 3954/87 and Commission Regulations (Euratom) No 944/89 and (Euratom) No 770/90.
[4] EC, 2013. Council Directive laying down basic safety standards for protection against the dangers arising from exposure to ionising radiation, and repealing Directives 89/618/Euratom, 90/641/Euratom, 96/29/Euratom, 97/43/Euratom and 2003/122/Euratom. EC Brussels, No. 2013/59/Euratom.



Based on data provided by dairy factories.

Figure 1 Impression of the spatial variation of ^{40}K activity concentrations ($Bq \cdot kg^{-1}$) in cow's milk in 2019.

2 Food

2.1 Introduction

The Netherlands Food and Consumer Product Safety Authority (NVWA) performs measurements on finished products from retail shops, wholesale produce auctions and distribution centres, while Wageningen Food Safety Research (WFSR) performs measurements on samples from earlier stages in the food production chain. In total about 2300 samples were analysed. The measurements performed on food sampled by the NVWA were carried out by WFSR according to SOP CHE01-WV143. The NVWA monitors activity concentrations in a 'mixed diet' every year by sampling and measuring separate ingredients. In 2019, 344 samples were taken from retail shops, wholesale produce auctions and distribution centres, including 43 sample of honey [5]. Though honey is not considered to be part of the mixed diet, samples are taken each year because it regularly contains elevated levels of radioactivity (mainly ^{137}Cs).The nuclide ^{137}Cs is of anthropogenic origin. The two main sources of ^{137}Cs in the environment are atmospheric nuclear weapons tests and some nuclear accidents, most notably the Chernobyl accident of 1986 and the Fukushima Daiichi accident of 2011. Previously deposited ^{137}Cs can end up in honey via vegetation and bees.

The separate ingredients were categorized into the following product groups: grain and grain products, vegetables, fruit and fruit products, milk and dairy products, salads, oil and butter, honey, tea, mineral water, and fish. The results from 2019 are presented in Table 2. With the exception of three samples of fresh mushrooms, none of the samples contained ^{137}Cs above the minimum detectable activity of 5 Bq·kg^{-1}. None of the samples exceeded the set limit for radiocesium activity (sum of ^{134}Cs and ^{137}Cs) of 600 Bq·kg^{-1} for food or 370 Bq·kg^{-1} for milk and dairy products [6, 7].

WFSR analysed radioactivity in food products as part of the governmental monitoring programme. Samples were taken throughout the year and measurements were carried out according to standard procedures. In 2019, 1966 food samples were analysed for the presence of γ-emitters according to SOP-N-0132, which is based on NEN 5623. The results are presented in Table 2. None of the samples exceeded the set limit for radiocesium activity (sum of ^{134}Cs and ^{137}Cs) of 600 Bq·kg^{-1} (for food) or 370 Bq·kg^{-1} (for dairy products).

Of these food samples, 224 samples were additionally analysed for ^{90}Sr content according to SOP-A-1097. The results are presented in Table 4. These results are well below the set limit for new emergency exposure

[5] Jaarverslag NPK 2019. Nederlandse Voedsel en Waren Autoriteit.
[6] EC, 2009. Council Regulation on the conditions governing imports of agricultural products originating in third countries following the accident at the Chernobyl nuclear power station. EC Brussels, No. 1048/2009.
[7] EC, 2008. Council Regulation on the conditions governing imports of agricultural products originating in third countries following the accident at the Chernobyl nuclear power station. EC Brussels, No. 733/2008.

situations of 750 Bq·kg^{-1} for major food products [8]. No limit for ^{90}Sr has been set for existing exposure situations as defined in [9].

WFSR also monitors food specifically for export certification. For this purpose, samples were analysed for ^{137}Cs and ^{90}Sr. All results were below the limits set for ^{137}Cs and below minimal detectable activity for ^{90}Sr.

2.2 Results for mushrooms

NVWA sampled fifteen samples of fresh mushrooms of which three contained ^{137}Cs. The three samples originated from three different countries, one sample came from Turkey (6.8 Bq·kg^{-1}), one sample came from Bosnia Herzegovina (123 Bq·kg^{-1}) and one sample (163 Bq·kg^{-1}) came from Belarus. Thus, no sample exceeded the limit of 600 Bq·kg^{-1} [6,7].

2.3 Results for game

In the product group 'game' analysed by WFSR, 20 samples of game contained ^{137}Cs. The activity varied from 5 to 61 Bq·kg^{-1}. Thus, no sample exceeded the limit of 600 Bq·kg^{-1} [6, 7].

2.4 Results for average daily intake

The measured concentrations of ^{90}Sr, ^{134}Cs and ^{137}Cs in food in Bq·kg^{-1} were converted to an average daily intake value per person per day (Bq·day^{-1}) using food consumption patterns [10], according to the method described in the Appendix. From these intake values, a contribution to the effective yearly dose was calculated using standard dose conversion coefficients for ingestion.

The average daily intake per person of ^{134}Cs, ^{137}Cs and ^{90}Sr is estimated at <5 Bq·day^{-1} for each of the three radionuclides. These estimates are mainly based on the minimal detectable activities for these radionuclides in the different food categories, as shown in Table 1 to Table 4.
The contribution to the effective yearly dose calculated from these average daily intake values is < 0.12 mSv. Because the dose is calculated predominantly based on the minimum detectable levels, the actual daily intake, and therefore the calculated dose, is probably much lower.

[8] Council Regulation (Euratom) 2016/52 of 15 January 2016 laying down maximum permitted levels of radioactive contamination of food and feed following a nuclear accident or any other case of radiological emergency, and repealing Regulation (Euratom) No 3954/87 and Commission Regulations (Euratom) No 944/89 and (Euratom) No 770/90.
[9] EC, 2013. Council Directive laying down basic safety standards for protection against the dangers arising from exposure to ionising radiation, and repealing Directives 89/618/Euratom, 90/641/Euratom, 96/29/Euratom, 97/43/Euratom and 2003/122/Euratom. EC Brussels, No. 2013/59/Euratom.
[10] CTM van Rossum et al., 2020. The diet of the Dutch - Results of the Dutch National Food Consumption Survey 2012-2016, RIVM report 2020-0083.

Table 2 Results of the analysis of food in 2019 for ^{134}Cs and ^{137}Cs as sampled by NVWA[(1)] the Netherlands Food and Consumer Product Safety Authority, in total 344 samples

Product	Number of samples	^{134}Cs [(2)] Bq·kg^{-1}	^{137}Cs [(2)] Bq·kg^{-1}
Grain and grain products	57	< 5 (0)	< 5 (0)
Vegetables and fruit products	90	< 5 (0)	< 5 (0)
Mushrooms	15	< 5 (0)	6.8 - 163 (3) [(3)]
Milk and dairy products	26	< 5 (0)	< 5 (0)
Meat and meat products	4	< 5 (0)	< 5 (0)
Poultry and game	2	< 5 (0)	< 5 (0)
Salads	22	< 5 (0)	< 5 (0)
Oil and butter	27	< 5 (0)	< 5 (0)
Honey	43	< 5 (0)	< 5 (0)
Tea	5	< 5 (0)	< 5 (0)
Mineral water	20	< 5 (0)	< 5 (0)
Fish	40	< 5 (0)	< 5 (0)

(1) Measurements were carried out by WFSR.
(2) Number of samples above the given reporting limit is shown in brackets.
(3) ^{137}Cs in fresh mushrooms from Turkey 6.8 Bq.kg^{-1}, from Bosnia Herzegovina 123 Bq.kg^{-1}, and from Belarus 163 Bq.kg^{-1}.

Table 3 Results of 2019 analysis of food for ^{134}Cs and ^{137}Cs as sampled and measured by WFSR, in total 1966 samples

Product	Number of samples	^{134}Cs [(1)] Bq·kg^{-1}	^{137}Cs [(1)] Bq·kg^{-1}
Raw milk	53	< 5 (0)	< 5 (0)
Vegetables	132	< 5 (0)	< 5 (0)
Fruits	102	< 5 (0)	< 5 (0)
Poultry	452	< 5 (0)	< 5 (0)
Pork	512	< 5 (0)	< 5 (0)
Beef/veal	320	< 5 (0)	< 5 (0)
Sheep/lamb	10	< 5 (0)	< 5 (0)
Game	86	< 5 (0)	5 – 61 (20)
Other meat and meat products	31	< 5 (0)	< 5 (0)
Eggs	74	< 5 (0)	< 5 (0)
Fish	79	< 5 (0)	< 5 (0)
Seafood	73	< 5 (0)	< 5 (0)
Ready meals	42	< 5 (0)	< 5 (0)

(1) Number of samples above the given detection limit is shown in brackets.

Table 4 Results of 2019 analysis of food for ^{90}Sr as measured by WFSR, in total 224 samples

Product	**Number of samples**	**^{90}Sr [1] $Bq \cdot kg^{-1}$**
Raw milk	53	< 5 (0)
Vegetables	21	< 5 (0)
Fruits	24	< 5 (0)
Poultry	11	< 5 (0)
Pork	10	< 5 (0)
Beef/veal	8	< 5 (0)
Sheep/lamb	0	
Game	8	< 5 (0)
Other meat and meat products	0	
Eggs	8	< 5 (0)
Fish	18	< 5 (0)
Seafood	21	< 5 (0)
Ready meals	42	< 5 (0)

(1) Number of samples above the given detection limit is shown in brackets.

3 Grass and feed

The National Monitoring Network of Radioactivity in Food (Landelijk Meetnet Radioactiviteit in Voedsel, LMRV), referred to in the previous section over milk, has been set up as an emergency network for monitoring relatively high contamination levels in case of an incident. It is an important monitoring network used in cases of a nuclear or radiological emergency, as described in the National Crisis Management Plan for Radiation Incidents (Nationaal Crisisplan Stralingsincidenten, NCS). In addition to measuring radioactivity levels in milk and food samples, the network is used to measure radioactivity levels in grass samples. For this purpose, reference pastures and fields have been designated across the Netherlands in proximity to the companies and organisations that participate in the LMRV. In this way, the extent of radioactive deposition can be assessed rapidly by the LMRV in the event of a nuclear or radiological incident.

It is important to have accurate and recent information on the natural background levels of radioactivity in grass to compare with samples analysed during a nuclear or radiological incident. For this reason, all LMRV locations are requested to take a grass sample every year from their reference pasture or field according to a standardised protocol, and to measure this sample using the food monitoring system.

In 2019, 42 grass samples were taken at 24 locations and measured on the food monitoring system. None of the grass samples taken contained artificial radionuclides above the minimal detectable activities. The minimal detectable activities were approximately 20 $Bq.m^{-2}$ (assuming a yield of 250 grams of grass per m^2) for the artificial radionuclides ^{60}Co, ^{131}I, ^{134}Cs and ^{137}Cs. Natural ^{40}K was found in all samples. In some samples, natural radionuclides from the uranium and thorium decay chains deposited during rainfall were detected as well. Figure 2 shows the spatial variation of the yearly average ^{40}K concentrations per region and the distribution of the sampling locations across the Netherlands.
In addition, 429 feed samples were analysed for γ-emitters as part of the monitoring programme of WFSR. No artificial radioactivity was found in these samples; the results for ^{134}Cs and ^{137}Cs were all lower than the minimal detectable activity (2 $Bq \cdot kg^{-1}$).

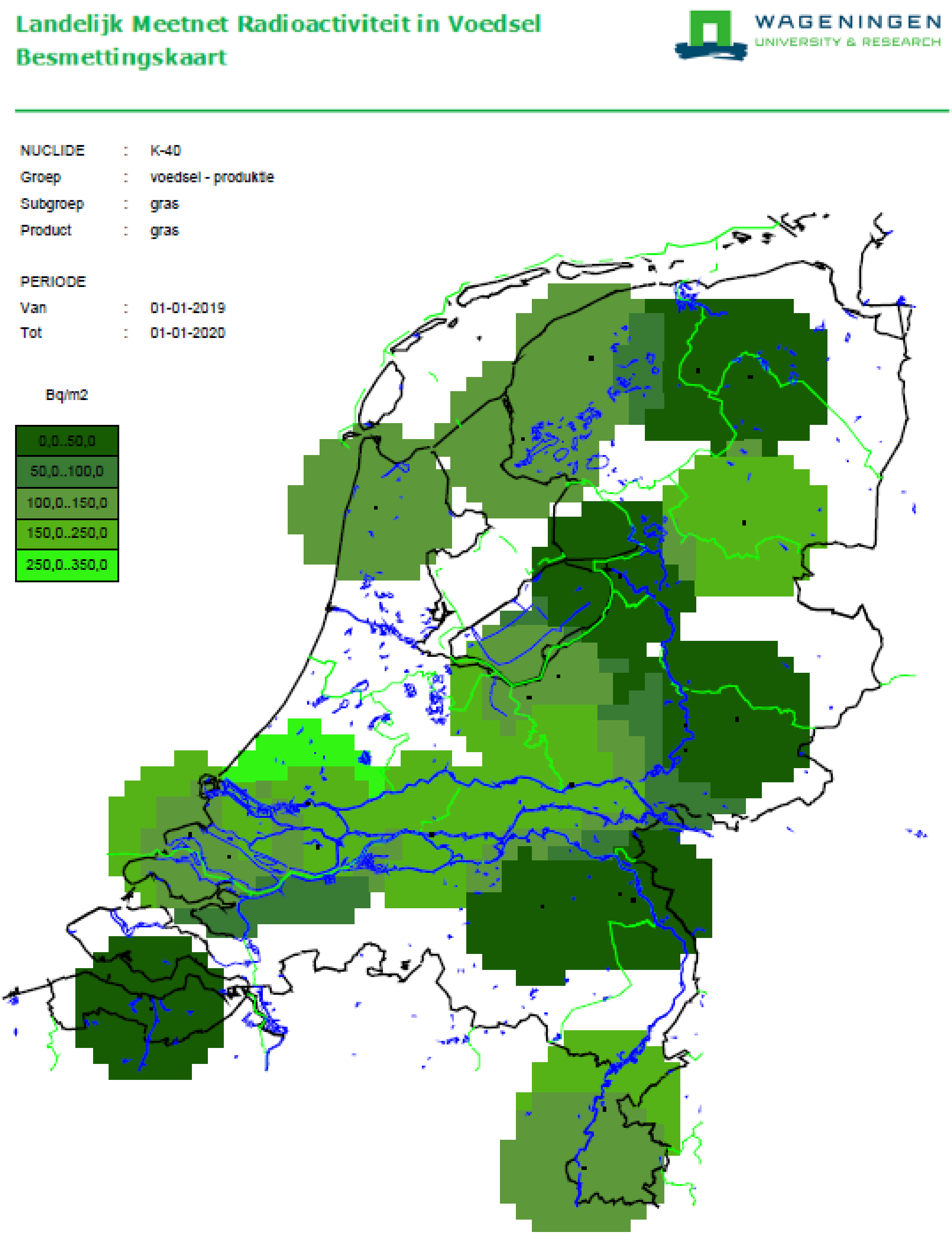


Figure 2 Impression of spatial variation of ^{40}K activity in grass in Bq·m^{-2}, measured in 2019.

Appendix: Mixed diet, conversion from Bq.kg^{-1} to intake in Bq.day^{-1}

With respect to the results presented for mixed diets, WFSR used food consumption patterns to convert the measured concentrations of ^{90}Sr, ^{134}Cs and ^{137}Cs in food (Bq·kg^{-1}) to an average daily intake value per person per day (Bq·day^{-1}). For the Netherlands, the food consumption patterns were investigated by the RIVM and the results can be found in the report 'The diet of the Dutch - Results of the Dutch National Food Consumption Survey 2012-2016' [10]. In this report, the consumption patterns are presented by food category, sex and age group in grams per consumption day, as well as the percentage of consumption days. For the calculations in the current report, these values were combined to produce an average consumption amount in g·day^{-1} for each food category, sex and age group.

For each sex and age group and specific radionuclide, the daily intake ($DI_{a,s,n}$) is then calculated as follows:

$$\mathrm{DI}_{a,s,n} = \sum_{i} \frac{\mathrm{DI}_{a,s,i}}{1000} \times \mathrm{AC}_{i,n}$$

where

$DI_{a,s,n}$ = daily intake per age group, sex and radionuclide (Bq·day^{-1});
i = food category;
$DI_{a,s,i}$ = daily intake per age group, sex and food category (g·day^{-1});
$AC_{i,n}$ = activity concentration per food category and radionuclide (Bq·kg^{-1}).

These daily intakes were then averaged over the different age groups and sexes to obtain the total daily intake per person for each radionuclide. To include the monitoring results of ready meals in the final result, the assumption was made that ready meals make up 10% of the consumption of the categories meat, fish and vegetables.

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