RADIOACTIVITY IN OUR SURROUNDINGS

2.1 Design: ASN and IRSN Communications Departments - October 2021
Graphic design and production: www.kazoar.fr - Pictograms: Freepik, Kazoar - Photos: David Claval/Médiathèque IRSN, Arnaud Bouissou/MEDDE/Médiathèque IRSN (multimedia library)

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RADIOACTIVITY IN OUR SURROUNDINGS

WHERE DOES RADIOACTIVITY COME FROM?

Even though radioactivity was only discovered a little over a century ago, it has always been here! From the dawn of the Earth, to the production of radioactive elements for medical examinations, its origins are manifold.

NATURAL RADIOACTIVITY

TERRESTRIAL RADIOACTIVITY

The rocks that make up the Earth have contained numerous radioactive elements since its formation. Granite, for example, is known to contain uranium.

Potassium-40, thorium, uranium and its by-products (radon, etc.)

COSMOGENIC RADIOACTIVITY

Our planet is also constantly bombarded by solar and interstellar particles, cosmic rays, which are responsible for some of the radioactivity measured on the ground and which increases with altitude. Also, under the influence of this radiation, the atoms making up the atmosphere give rise to radioactive elements.

Tritium, carbon-14, beryllium-7, etc.

ARTIFICIAL RADIOACTIVITY

DISCHARGES FROM FACILITIES

Nuclear facilities in operation produce liquid and gaseous discharges. They are subject to regulations and are monitored by the authorities.

Tritium, carbon-14, noble gases (krypton, etc.), iodine, caesium, cobalt, etc.

MEDICAL WASTE

In the medical field, certain applications such as scintigraphy, require the injection of short-lived radioactive substances into the patient. Even if their radioactivity decreases rapidly, some of it is released into the environment through urine. Radioactive product manufacturing facilities also induce small-scale discharges, which are regulated and controlled.

Fluorine-18, iodine-131, etc.

THE LEGACY OF THE PAST

ATMOSPHERIC NUCLEAR TESTING

Since the discovery of radioactivity, its use has evolved with the development of its applications, both civil and military. During the Cold War, a large number of atmospheric nuclear tests projected many radioactive elements at high altitude due to the reactions that occurred during the explosions.

Caesium-137, strontium-90, plutonium-239 and plutonium-240 still visible today

ACCIDENTS

Major nuclear accidents, such as those at Chernobyl and Fukushima, have also disseminated radioactive elements over small or large territories. The radioactive elements contained within the facilities at the time of the accident were no longer confined and caused radioactive pollution.

Caesium-137 still visible in France

HISTORIC POLLUTION

Finally, industries that used or produced radioactive substances (watchmaking, production of radium objects, etc.) may have also caused pollution, particularly in the first half of the 20th century, on or near their sites, which is still visible today.

Radium still present today

2.2 Design: ASN and IRSN Communications Departments - October 2021
Graphic design and production: www.kazoar.fr - Pictograms: Freepik, Kazoar
Photos: Gérard Bouchez/Médiathèque IRSN, Scott Kelly/NASA, David Claval/Médiathèque IRSN, Jacques-Antoine Maisonobe/AP-HP, United States Department of Energy, Tim Porter, Noak/Le bar Floréal/ Médiathèque IRSN

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RADIOACTIVITY IN THE AIR

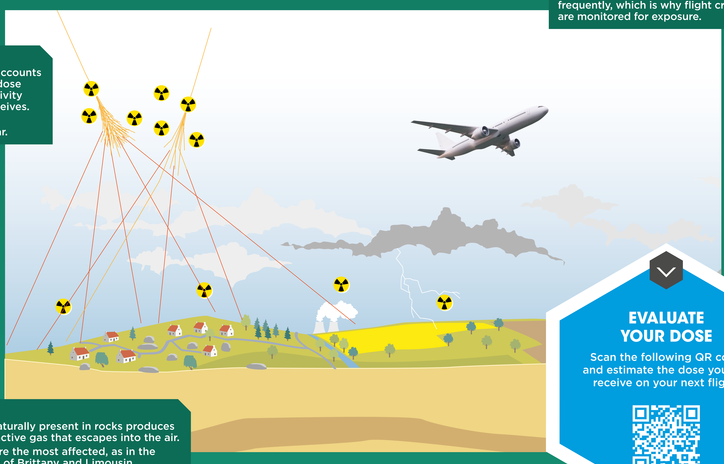
Our atmosphere is penetrated by **natural radiation** from the ground and from space. Artificial radioactive elements resulting from **human activities** are also present.

NATURAL RADIOACTIVITY IN THE AIR

We are constantly receiving cosmic radiation from the far reaches of the universe. Tens of thousands of particles hit every square metre of the Earth every second. When they come into contact with our atmosphere, these cosmic rays and particles are responsible for the formation of radioactive elements such as tritium, beryllium-7 and carbon-14.

THE HIGHER YOU GO, THE LESS PROTECTION YOU HAVE AGAINST COSMIC RADIATION.
When we fly, we are more exposed to radiation from space. A flight from Paris to New York is roughly equivalent to the dose of radioactivity received during a panoramic dental X-ray. This is not a very high dose of radiation, but it can start to count when you travel very frequently, which is why flight crews are monitored for exposure.

COSMIC DOSE
Cosmic radiation accounts for 15-20% of the dose of natural radioactivity that each of us receives. This represents 0.3 to 0.5 mSv/year.



RADON
The uranium naturally present in rocks produces radon, a radioactive gas that escapes into the air. Granitic soils are the most affected, as in the French regions of Brittany and Limousin.

EVALUATE YOUR DOSE
Scan the following QR code and estimate the dose you will receive on your next flight.

ARTIFICIAL RADIOACTIVITY IN THE AIR

Between 1945 and 1980, more than 500 nuclear tests were carried out in the atmosphere. The radioactive elements released by the explosions remained a few hours to several months in the atmosphere before falling back to earth.

Nuclear facilities also release radioactive elements into the air such as tritium, carbon-14 and iodine-131.

Doses due to atmospheric nuclear testing

The concentrations of radioactive elements in the air were at their highest in 1963, leading to the largest radioactive deposits, as well as significant contamination of the food chain, particularly by caesium-137 and strontium-90.

In France, the average dose received by the population that year was of the same order of magnitude as that of 1986, due to fallout from Chernobyl, i.e. 0.3 mSv.

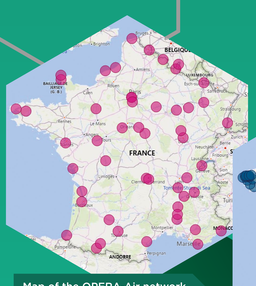
MONITORING RADIOACTIVITY IN THE AIR

Gaseous discharges from nuclear facilities are monitored by their operators, under the supervision of ASN to ensure compliance with regulatory values. The impact of these discharges on the environment is assessed by the operators and IRSN.

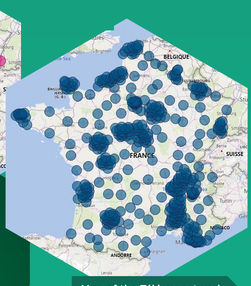
Several systems exist for air monitoring: the IRSN Teleray network measures ambient radioactivity, whereas the IRSN Opera-Air network collects aerosol particles on filters to analyse the radionuclides present in the air.

It can detect minute traces of radioactivity, a few tens of nBq/m³ of air, i.e. just a few disintegrations in more than 100,000,000 m³ of air!

Other radioactive elements may be present in the form of gases, such as tritium or carbon-14. Specific systems called "bubblers" or "passive samplers" are used. Most OPERA-Air stations include iodine sampling devices on activated charcoal cartridges, which would be used in case of a nuclear accident for example.



Map of the OPERA-Air network



Map of the Téléray network

CONTINUOUS MEASUREMENTS
Ambient dose rate is continuously measured by IRSN using more than 400 Teleray probes. The Teleray network produces tens of millions of measurements every year.

2.3 Design: ASN and IRSN Communications Departments - October 2021
Graphic design and production: www.kazoar.fr - Pictograms: Freepik, Kazoar - Illustration: La-fabrique-créative - Photos/cards: IRSN

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RADIOACTIVITY IN SOIL

From the early days of the Earth, soil has been naturally rich in radioactive elements. Since the 20th century, mankind has added a proportion of artificial radioactivity.

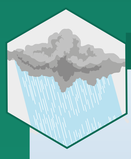
NATURAL RADIOACTIVITY IN SOIL

Many radioactive elements such as potassium, uranium, radium, and thorium are present in the earth's crust. Their concentration varies according to the nature of the soil. Radioactivity is therefore 5 to 20 times higher in granitic soils than in other soils.

ARTIFICIAL RADIOACTIVITY IN SOIL

During normal operation, nuclear facilities release very small quantities of radioactive elements into the air. These are deposited on soils and plants and are absorbed by them.

The artificial nuclides present in the soils of mainland France today essentially originate from fallout due to nuclear tests conducted in the northern hemisphere and the Chernobyl accident.



Rain transfers radioactive elements from the air into the soil.

Some rocks contain uranium, thorium and radium, and radon gas escapes from them.

Plants absorb radioactive elements from the soil through their roots.

MONITORING RADIOACTIVITY IN SOIL

Monitoring radioactivity in the terrestrial environment is essentially based on sampling. To measure recently deposited radioactive elements, the soil surface is sampled. To determine how they have migrated over time, core samples are taken. They provide information about the history of the soil, going back decades, depending on the depth of the sample.

Other methods allow gamma rays emitted by the soil to be measured directly, without prior sampling: this is known as *in situ* gamma spectrometry. Although less effective than laboratory analysis, it can quickly provide valuable information about the radioactive elements present.

Example of a soil core sample.

In situ gamma spectrometry measurements near the Saint-Alban nuclear power plant.

Plants that grow in the ground

are also valuable indicators, as they draw the elements they need to grow from the soil.

Root vegetables such as potatoes, beetroot and onions will capture radioactive elements, both natural and artificial, present in the soil.

Their analysis will provide information about the cultivated soil.

2.4 Design: ASN and IRSN Communications Departments - October 2021
Graphic design and production: www.kazoar.fr - Pictograms: Freepik, Kazoar - Illustrations: La-fabrique-créative, B2 infographie - Photos: Maxime Morin/IRSN, Martial Chevreuil/Médiathèque IRSN

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RADIOACTIVITY IN OUR SURROUNDINGS

RADIOACTIVITY IN WATER

Water contains radioactive elements not only from the earth, but also from the atmosphere. It also reflects human activities involving radioactivity.

NATURAL RADIOACTIVITY IN WATER

Water naturally contains radioactive elements, some of which come from the ground through which it flows. These elements will end up in groundwater and rivers.

Mineral water drawn from granitic soil may contain potassium-40, radon or dissolved uranium, and is therefore naturally more radioactive than surface water.

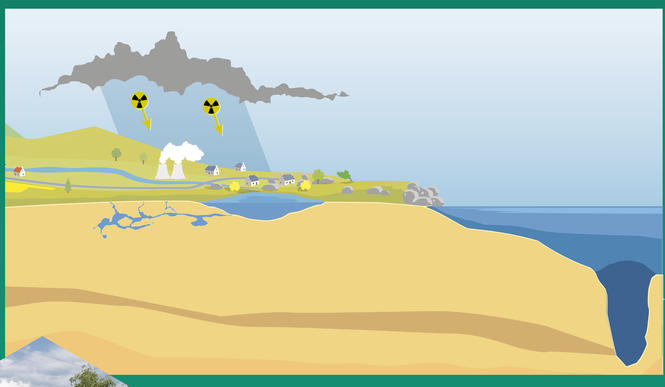
Seawater is also naturally radioactive: it contains tritium and polonium, which are absorbed by fish, shellfish and crustaceans.

ARTIFICIAL RADIOACTIVITY IN WATER

During normal operation, nuclear power plants release radioactive elements in liquid form, which can find their way into rivers and the sea, and then into living aquatic organisms.

Water also contains radioactive elements derived from fallout due to nuclear testing and the Chernobyl accident.

The total activity of seawater due to radioactive elements is around 14 Bq/L. It is 90% due to the potassium-40 naturally present in water. These radioactive elements can become concentrated in seafood.



Sampling in the Lauzon, south of the Tricastin site.

MONITORING RADIOACTIVITY IN WATER

Like gaseous emissions, discharges from nuclear facilities are subject to threshold values set by ASN. Their impact on the environment is also measured and monitored by the operators and by IRSN.

In addition to the Hydrotéléray system, which measures radioactivity in rivers, water samplers take high-frequency samples of water downstream of nuclear sites and in the discharge channels of nuclear power plants on the coast to determine the radionuclides present in greater detail.

IRSN's facilities are also equipped with tanks for settling suspended matter in water, making it possible to analyse the radionuclides present in these particles transported by the current.

Manual sampling of water and sediment in river beds is carried out. The latter, which result from the gradual deposition of matter, are therefore representative of the radioactivity accumulated over time.

Aquatic flora and fauna are also monitored. Fish, molluscs, algae and even plants absorb radioactivity, both natural and artificial, throughout their lives. Taking and measuring samples therefore provides valuable information, not only about the different stages in the food chain, but also more generally about the radioactive elements present.

CONTINUOUS MEASUREMENTS

Ambient radioactivity in rivers is measured continuously using automatic detectors.

Seven Hydrotéléray stations are dedicated to the continuous monitoring of rivers downstream of nuclear facilities.

Hydro-collector

DEBATE
SUBMERSION OF RADIOACTIVE WASTE

Since 1946, many countries have dumped their waste into the oceans. In Europe, the UK and Belgium have submerged them in the Casquets trench north-west of Cap de La Hague, and France in the open sea off Galicia and Brittany.

The submersion of radioactive waste in the seabed had been considered safe by the scientific community. The dilution and presumed duration of isolation provided by the marine environment seemed sufficient.

The dumping of waste at sea is now prohibited under the London Protocol, signed in 1996 and ratified in 2006 by 30 countries, including France.

France stopped dumping waste after 1969. It has built storage and disposal centres on land.

2.5 Design: ASN and IRSN Communications Departments - October 2021
Graphic design and production: www.kazoar.fr - Pictograms: Freepik, Kazoar - Illustration: La-fabrique-créative - Photos: Noak/Le bar Floréal/ Médiathèque IRSN, Arnaud Bouissou/MEDDE/Médiathèque IRSN

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FROM THE ENVIRONMENT TO THE TABLE

Animals and plants draw their resources from air, water and soil. Radioactive elements are thus found throughout the food chain.

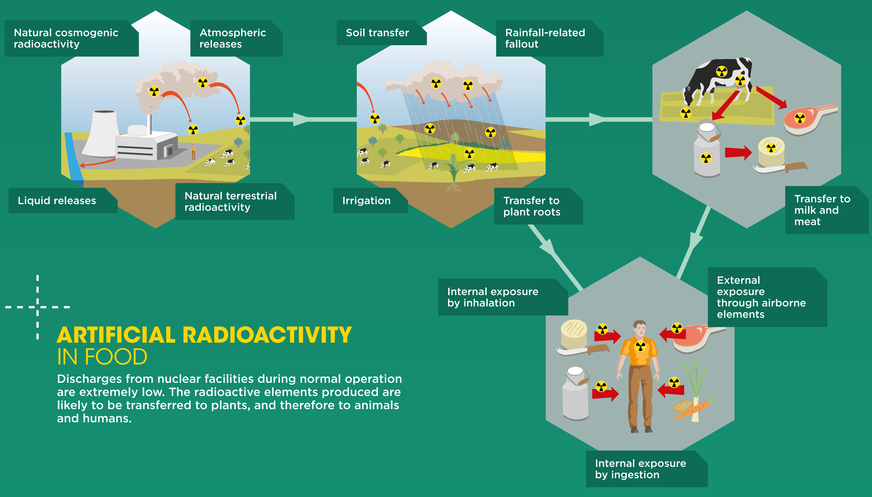
NATURAL RADIOACTIVITY IN FOOD

Foodstuffs are naturally radioactive because they contain numerous radionuclides, including potassium-40, carbon-14, or polonium-210. One kilogram of potatoes, for example, contains around 130 Bq of potassium-40.

Water, which naturally contains tritium or traces of uranium, is also radioactive.

THE AVERAGE DIET-RELATED DOSE

is estimated at 0.55 mSv/year.



ARTIFICIAL RADIOACTIVITY IN FOOD

Discharges from nuclear facilities during normal operation are extremely low. The radioactive elements produced are likely to be transferred to plants, and therefore to animals and humans.

MONITORING RADIOACTIVITY IN FOODSTUFFS

Radiological monitoring takes into account discharges from nuclear facilities, but also local and seasonal food production.

The operator monitoring program is required to integrate the radioactivity analysis of local foodstuffs around the facilities.

At the national level, various bodies are involved in monitoring radioactivity in food: the Directorate-General for Food (DGAL), the Directorate-General for Competition, Consumer Affairs and Fraud Control (DGCCRF) and IRSN, with a joint national agreement between these three bodies.

REGULATED DRINKING WATER

The World Health Organisation (WHO) estimates that the total indicative dose per capita from drinking water should not exceed 0.1 mSv/year, based on a consumption of 2 litres per day.

A number of water quality criteria and limits have been set. For example, water intended for human consumption must not contain more than 10,000 Bq/L of tritium.

In 2013, an IRSN study provided a comprehensive overview of the radiological quality of bottled water produced in France. Of the 75 spring waters and 67 mineral waters analysed, 6 exceeded the recommended threshold of 0.1 mSv/year for total indicative dose (TID).

Radiological quality assessment

Take a look at the radiological quality report on mineral waters marketed in France by scanning the following QR Code.

2.6 Design: ASN and IRSN Communications Departments - October 2021
Graphic design and production: www.kazoar.fr - Pictograms: Freepik, Kazoar - Illustrations: La-fabrique-créative/Bruno Bourgeois - Photos: Arnaud Bouissou/MEDDE/Médiathèque IRSN, rawpixel.com/Freepik

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RADIOACTIVITY
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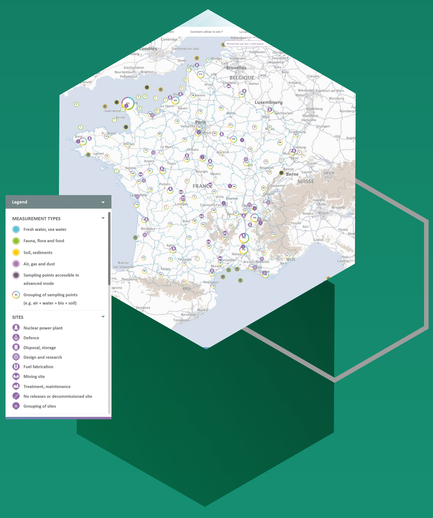
LEARN MORE ABOUT RADIOACTIVITY AROUND YOU

Many different actors carry out radioactivity measurements in the French environment: nuclear facility operators, government departments, IRSN and NGOs. ASN has set up the **Réseau national de mesures de la radioactivité de l'environnement (RNM - National network for environmental radioactivity measurements)**, which centralises all the data, ensures its quality and harmonisation, and makes it available via an Internet interface.



WHAT MEASUREMENTS?

Nuclear operators are required to transmit and make available to the public all the results of the regulatory environmental monitoring they carry out around their facilities.

IRSN also transmits all the results obtained as part of its national radiological monitoring.

Generally speaking, any data producer can send the results of its environmental radioactivity analyses to the RNM if it has the required ASN approval.

ARE THESE MEASUREMENTS RELIABLE?

An ASN approval procedure ensures that the data transmitted to the RNM complies with a high quality standard. It includes compliance with international standards and participation in comparisons between laboratories organised by IRSN, and is also based on inspections of the laboratories.

HOW CAN I ACCESS DATA?

All data is available online at **www.mesure-radioactivite.fr**.

Understanding radioactivity is not always easy at first. The data is therefore accompanied by graphics and explanations to contextualise and enrich the measurement results, making them easier to interpret and understand.

RADIOACTIVITY NEAR ME

Since 2010, the **www.mesure-radioactivite.fr** website has hosted the 300,000 measurements taken each year in France in different environments (air, water, soil, fauna and flora) and in food products to make them accessible to everyone, in complete transparency.

You can consult statistical data for a departement or around a nuclear site: number and type of samples and measurements (air, water, food, etc.), local monitoring players. All the results are displayed on a map, with the option of geolocation.

An expert mode gives you access to a wide range of filters, making it easy to obtain the information you need by selecting multiple criteria.

2.7 Design: ASN and IRSN Communications Departments - October 2021
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