OSPAR COMMISSION

Radioactive Substances Committee Thematic Assessment

OSPAR

QUALITY STATUS REPORT 2023

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OSPAR's Quality Status Report 2023

Radioactive Substances Committee Thematic Assessment

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Executive summary

Society's need for energy, industrial processes, health and wellbeing and national security have resulted in past and present human activities that have led to the introduction of radionuclides to the marine environment. Activities linked to the production of energy (nuclear sector) have led to discharges of artificial radionuclides, while extraction of oil and gas activities have resulted in the discharge of naturally occurring radionuclides. Industrial uses, research, survey and educational activities and medical uses have also led to discharges of radionuclides. Military activities such as atmospheric nuclear weapons testing and other sources such as the Chernobyl accident have resulted in further inputs of radionuclides to the marine environment.

Under the Radioactive Substances Strategy (RSS) of the North-East Atlantic Environment Strategy (NEAES) 2010-2020, OSPAR's aim was to reduce inputs and levels of radionuclides. From the assessments carried out by OSPAR on data available up to 2018, there is clear evidence for the nuclear sector of progressive and substantial reductions in discharges in the majority of cases. For the oil and gas sub-sector there is evidence of some reductions in discharges. However, in most cases discharges of radioactive substances from this sub-sector have remained unchanged. As to indicator radionuclides for the nuclear sector, there is clear evidence that current environmental concentrations are close to or lower than historic levels. The environmental concentrations of indicator radionuclides for the nuclear sector and modelled additional concentrations of indicator radionuclides for the oil and gas sub-sector would not result in a significant radiological impact on humans or the marine environment.

It can be concluded that Contracting Parties have successfully fulfilled the objectives of the OSPAR RSS for 2020 under the NEAES 2010-2020 and have made significant progress towards fulfilling *the ultimate aim of concentrations in the environment near background values for naturally occurring radioactive substances and close to zero for artificial radioactive substances*. In doing so, Contracting Parties have prevented pollution of the OSPAR Maritime Area by ionising radiation. As delivering the aims of the OSPAR Convention is an ongoing task, new strategic and operational objectives for radioactive substances have been agreed by OSPAR under the new NEAES 2030.

Q1. Identify the problems? Are they the same in all OSPAR Regions?

Radioactive substances affect living organisms

Radioactivity is associated with energy released from radionuclides through radiation. Ionising radiation occurs as electromagnetic rays (γ-rays), α-particles and β-particles. It can cause genetic, reproductive, cancerous as well as acute effects in living organisms. Because of this, it has the potential to cause negative effects on marine organisms at the level of populations and to affect human health through, for example, seafood consumption. The potential for harm through radiation depends on the properties of the radionuclides, the amount of radiation energy absorbed by marine organisms (i.e. the dose) and the pathway through which they are exposed.

Impact across the OSPAR Regions

As was the case for the Quality Status Report (QSR) 2010, the main sources from which radioactive substances are discharged into the OSPAR Maritime Area are the nuclear sector (associated with electricity generation) and the non-nuclear sector (mainly the offshore oil and gas industry). The contribution to environmental concentrations from liquid discharges of radioactive substances from the nuclear and non-nuclear sectors is greatest within the area where discharges occur. The majority of discharges of radioactive substances from the nuclear and non-nuclear sectors occur in OSPAR Regions II (Greater North Sea) and III (Celtic Seas). Discharges of radioactive substances can be transported away from discharge points by ocean currents to other parts of the OSPAR Maritime Area, where environmental concentrations are typically lower than in the areas where the discharges originated. However, in some cases marine biota have the ability to accumulate levels of radionuclides to a relatively high degree, even if environmental concentrations in seawater are low.

The nuclear sector is the main source of artificial radionuclides

The number of nuclear sector sites in OSPAR countries discharging radionuclides directly or indirectly to the OSPAR Maritime Area has decreased in the past ten years. In 2021, the 82 nuclear sites (**Figure 1**) in operation or undergoing decommissioning in the OSPAR catchment area comprised: nuclear power plants, which harness the heat produced in nuclear reactions and convert this to electrical energy; nuclear fuel reprocessing plants, which recycle used nuclear fuel to recover uranium and plutonium; nuclear fuel fabrication and enrichment plants, which provide the uranium fuel for the power plants; and research and development facilities relating to all aspects of the nuclear sector and which can include the production of radionuclides for medical or industrial purposes.

Discharges from the nuclear fuel reprocessing sub-sector remain the dominant source of discharges from the nuclear sector, although they are lower than during the period 1995 to 2001. In the period 2012 to 2018, this sub-sector contributed 92% of total alpha discharges and 67% of total beta (excluding tritium) discharges from the nuclear sector. The radionuclides used as indicators of discharges from the nuclear sector are caesium-137 (Cs-137), technetium-99 (Tc-99), plutonium-239,240 (Pu-239,240) and tritium (H-3). OSPAR has recognised that the industrial-scale abatement of tritium in the liquid effluent of nuclear power stations and nuclear reprocessing facilities is currently not technically feasible. Therefore, discharges of tritium are not currently assessed but discharge data for tritium is reported to OSPAR.

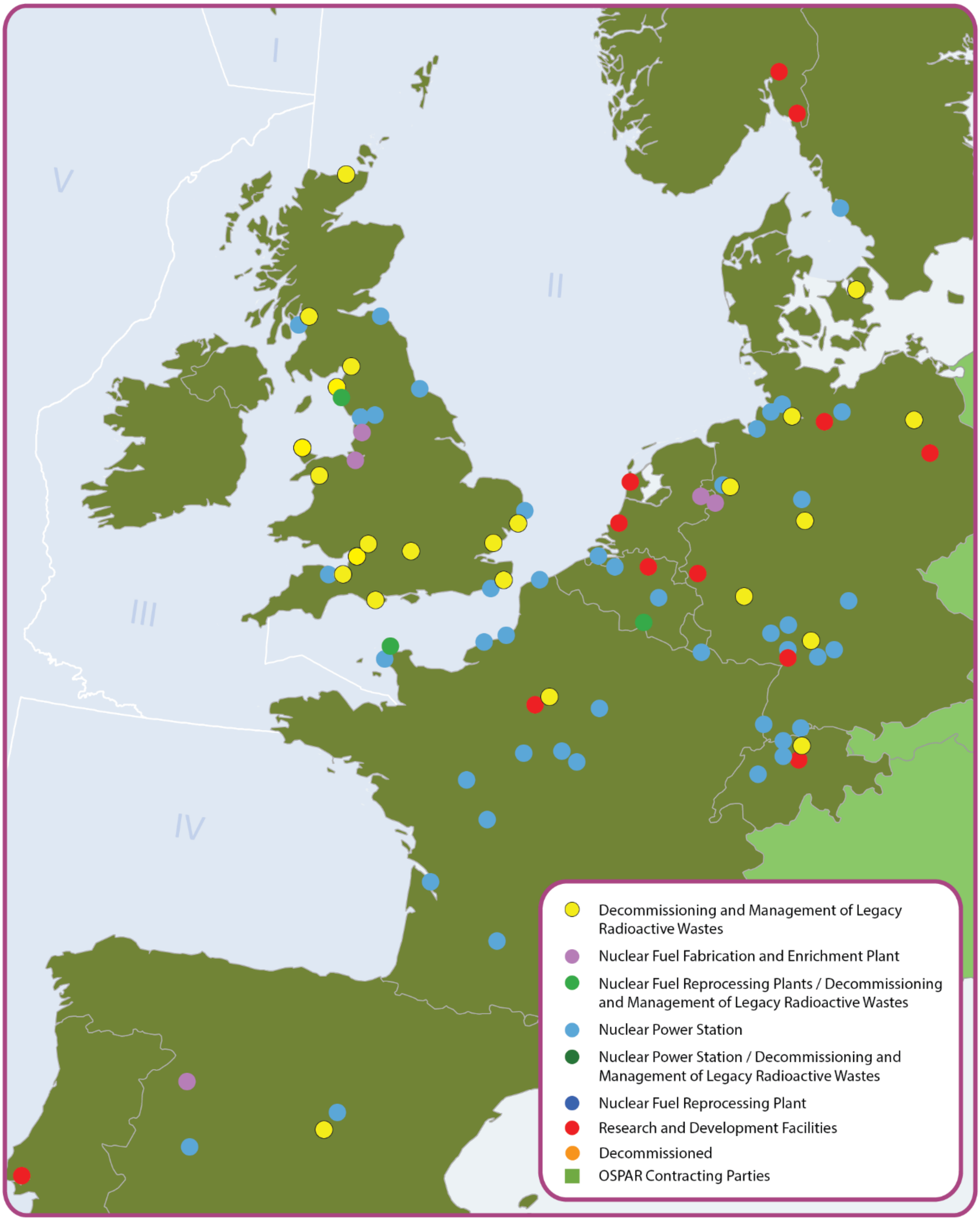


Figure 1: Nuclear sites for which discharges were reported by Contracting Parties to OSPAR in the period 1995 to 2018. The status of these sites may have changed from operational to decommissioning during the reporting period.

Offshore oil and gas activities discharge naturally occurring radionuclides

The offshore oil and gas industry is the largest non-nuclear contributor to the discharges of radioactive substances to the marine environment. Almost all the radionuclides discharged from this sector are from produced water (water extracted from the reservoir with the oil and gas) with smaller contributions from the descaling of pipes. The naturally occurring radionuclides in produced water include lead-210 (Pb-210), polonium-210 (Po-210), and radium-226 (Ra-226) and radium-228 (Ra-228). A less important source is the use of radioactive substances (e.g. tritium) as tracers.

Other non-nuclear sources are minor

An increasing number of radionuclides are used in medicine for therapy and diagnosis. The half-life[1] of the large majority of these radionuclides is so short (usually less than one day) that they do not reach the marine environment after they are discharged. The main source of radioactive discharges from the medical sector to the marine environment is from the use of radioactive iodine-131 (I-131) in the treatment of thyroid complaints. However, the combination of the relatively short half-life of I-131 (eight days) and the use of delay tanks and discharge routes via municipal sewers, means that far lower levels reach the marine environment than are administered to patients. Several Contracting Parties report data to OSPAR for a number of other non-nuclear sub-sectors. From the data that have been reported for the university and research centre sub-sector, it is reasonable to conclude that this sub-sector is not a significant contributor to tritium or total beta (excluding tritium) discharges and that there are no alpha discharges. Radiochemical production is carried out in several Contracting Parties, but the discharges from this sub-sector are in some cases included with those from the nuclear research and development sub-sector due to co-location of sites. Discharges of naturally occurring radionuclides have been reported by some Contracting Parties for phosphate production, titanium dioxide pigment manufacture, primary steel manufacture and rare earth mineral production. From the data that have been reported to OSPAR it is reasonable to conclude that these sub-sectors are no longer a significant contributor to total alpha and total beta (excluding tritium) discharges.

Other sources of radionuclides to the marine environment

It is important to note that not all radionuclides present in the North-East Atlantic marine environment are the result of authorised discharges from the nuclear and non-nuclear sectors. There have been a number of accidents and events, such as the Chernobyl accident in 1986 and fallout from atmospheric nuclear weapons testing in the 1950s and 1960s, which have resulted in the introduction of radionuclides to the marine environment. Other industrial activities have also released radionuclides into the marine environment as a consequence of their processes. In many cases, the additional sources of radionuclides from these historical accidents and events are still detectable today and will generally be indistinguishable from past and contemporary discharges of radionuclides. For this reason, monitoring data for environmental concentrations of radioactive substances reflect the sum of contributions from historical accidents and events and past and contemporary discharges of radionuclides. In addition, environmental concentrations of naturally occurring radionuclides by definition will also contain natural background levels of these radionuclides.

Future developments

A number of the nuclear power stations and other nuclear facilities that have been in operation over the last decades are now either decommissioned or will be decommissioned over the next decade. Although operational discharges from these facilities will cease, discharges associated with decommissioning will continue for a period of time during which there could be some fluctuations in the amount of radioactive

[1] The time taken for the radioactivity of a specified isotope to fall to half its original value

substances discharged from year to year. Currently, there are two new civilian nuclear power stations under construction that will contribute additional discharges to the OSPAR Maritime Area, but other projects are under discussion. In addition, some Contracting Parties are examining the possible construction and use of small modular reactors as an alternative model for energy production to the larger scale nuclear power stations in use today.

For the oil and gas sub-sector, the current trend of declining production and associated produced water volumes as well as increasing decommissioning activities would be expected to continue.

Q2. What has been done?

Use of Best Available Techniques to reduce radioactive discharges

OSPAR's work to prevent and reduce pollution from radioactive substances has focused on the nuclear sector and the application of Best Available Techniques (BAT). Examples of BAT for the nuclear sector include treatment systems for converting radionuclides in effluents into solid waste for disposal. Even when BAT is applied, low-level radioactive discharges into the environment are usually unavoidable. Such discharges are regulated through authorisations from the authorities. Regular reports to OSPAR indicate that the use of BAT is stipulated in national legislations and regulations and that management systems are in place to minimise radioactive discharges from the nuclear sector to the extent possible. OSPAR Contracting Parties also use BAT to prevent pollution from oil and 'other substances' caused by discharges of produced water, and this can also result in reduced discharges of naturally occurring radionuclides.

Monitoring programmes and assessment methodologies developed

OSPAR has established common tools and methods for monitoring and reporting discharges from the nuclear and non-nuclear sectors as well as environmental concentrations. Baselines have been established against which progress in reducing discharges and environmental concentrations can be monitored. Statistical methods to evaluate progress have also been identified. An approach for modelling additional concentrations of indicator radionuclides from discharges of produced water from the oil and gas sub-sector has been developed. OSPAR has also agreed a methodology to assess the radiological impact of environmental concentrations in the OSPAR Maritime Area. The work of OSPAR complements that by other international organisations, such as the European Commission (EU) and the International Atomic Energy Agency (IAEA).

OSPAR, through the Radioactive Substances Committee (RSC), undertakes periodic evaluations to analyse the progress that Contracting Parties to the OSPAR Convention have made against the objectives of the OSPAR Radioactive Substances Strategy (RSS). The Fifth Periodic Evaluation (5PE) published in 2022, is a comprehensive evaluation that assesses authorised discharges from the nuclear and non-nuclear sectors, environmental concentrations of radionuclides in the OSPAR Maritime Area and the radiological consequences of those concentrations. The 5PE assesses data available up to 2018 and builds upon the data and conclusions of the previous four periodic evaluations to provide the scientific underpinning for the Radioactive Substances Thematic Assessment for the QSR 2023.

Q3. Did it work?

Discharges of radioactive substances from the nuclear sector have shown progressive and substantial reductions

OSPAR has carried out assessments of indicators for each nuclear sub-sector (for individual Contracting Parties where discharges from these sub-sectors occur to the OSPAR Maritime Area and for the sum of all such discharges) as well as for the nuclear sector as a whole (the sum of all such discharges from all sub-sectors). These assessments have determined whether there were progressive reductions over the period 1995 to 2018 and substantial reductions in discharges in the assessment period of 2012 to 2018 compared to the baseline period (1995 to 2001). The combination of these outcomes has been used to determine whether the discharge element of the first objective of the OSPAR RSS under the North-East Atlantic Environment Strategy (NEAES) 2010-2020 has been fulfilled. From the assessments carried out there is clear evidence that the discharge element of the first objective of the OSPAR RSS under the NEAES 2010-2020 has been fulfilled in the majority of cases, that is, in these situations there have been progressive and substantial reductions in discharges. Further, it should be noted that no assessments revealed any actual increase in discharges.

For the nuclear sector as a whole, there was evidence that the discharge element of the first objective of the OSPAR RSS under the NEAES 2010-2020 had been fulfilled for total alpha, total beta (excluding tritium), Tc-99 and Cs-137. Compared to the baseline period, there had been overall reductions in total alpha discharges by a factor of around 2 and by a factor of 13 for total beta (excluding tritium). **Figure 2** shows the reductions in total alpha and total beta (excluding tritium) for the four nuclear sub-sectors. Overall discharges of Tc-99 and Cs-137 showed reductions by a factor of 66 and around 3, respectively. In the case of Pu-239,240, although the statistical assessment showed no evidence that the discharge element of the first objective of the OSPAR RSS under the NEAES 2010-2020 had been fulfilled, discharges of Pu-239,240 from the nuclear sector as a whole showed a reduction by a factor of 1,2. It is anticipated that discharges of Pu-239,240 will continue to decrease following the cessation of nuclear fuel reprocessing operations at Sellafield which is expected during 2022.

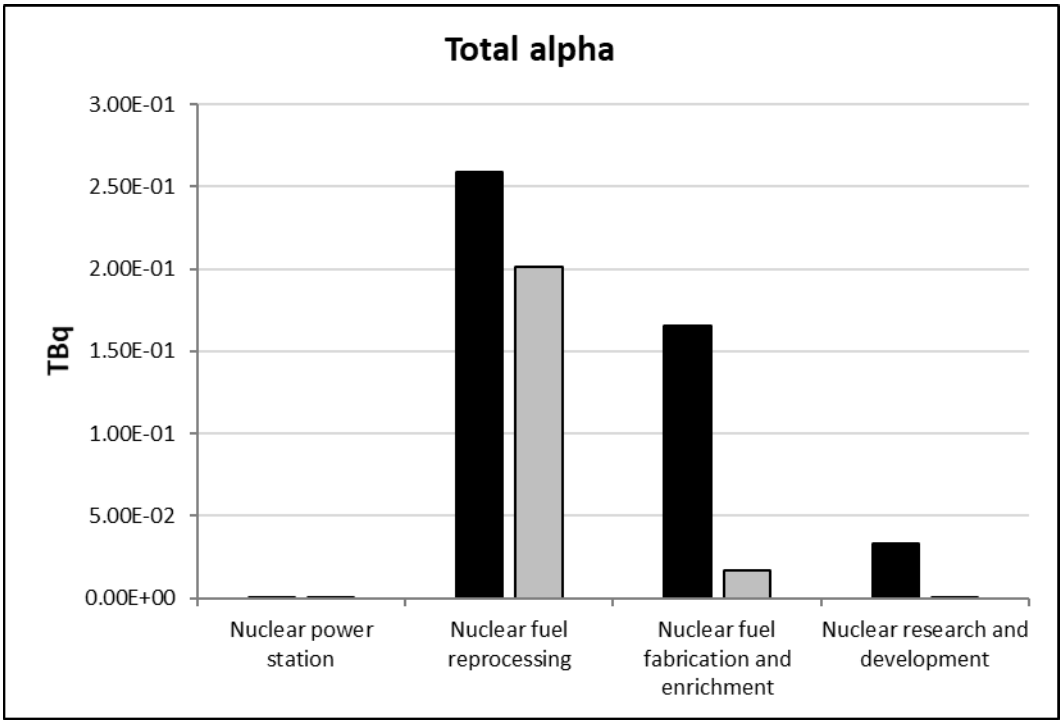


Figure 2: Comparison of mean total alpha discharges for the baseline period 1995-2001 (black columns) and assessment period 2012-2018 (grey columns) for the different nuclear sub-sectors.

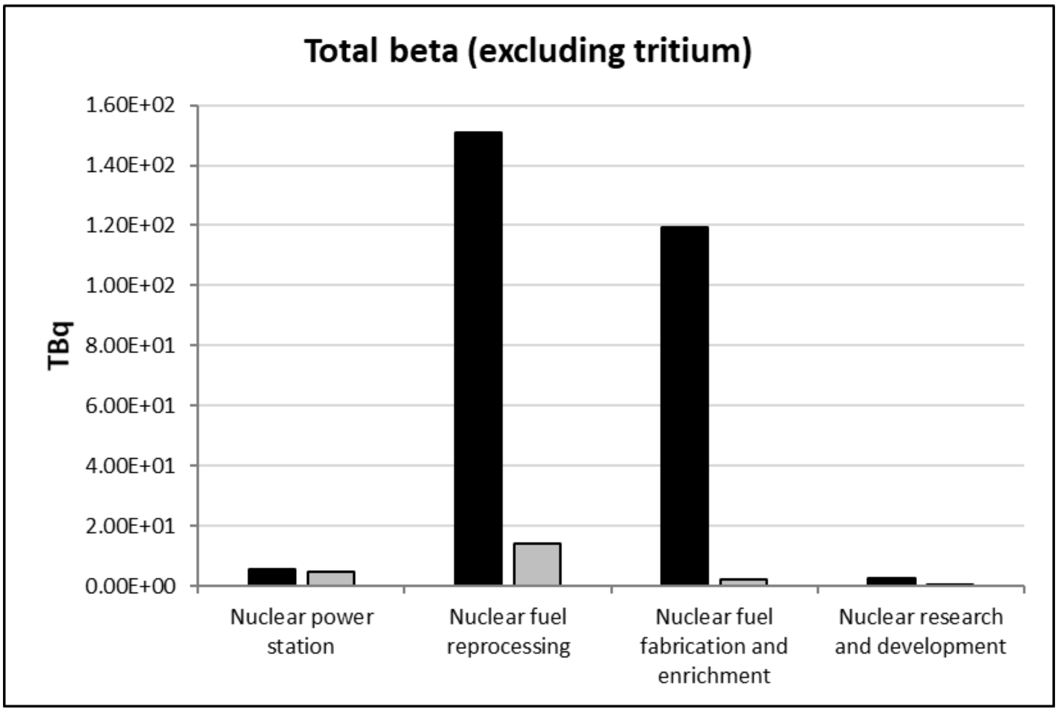


Figure 3: Comparison of mean total beta (excluding tritium) discharges for the baseline period 1995-2001 (black columns) and assessment period 2012-2018 (grey columns) for the different nuclear sub-sectors.

Best Available Techniques have been implemented in the nuclear sector

Contracting Parties have now completed seven rounds of reporting under PARCOM Recommendation 1991/4 on the implementation of BAT in the nuclear sector and have begun a further round of reporting under the new OSPAR Recommendation 2018/1 (as amended). Reporting rounds 5, 6 and 7 were completed during the period 2010 to 2020. Implementation reports for individual Contracting Parties and overviews of all national statements after the completion of each round of reporting under PARCOM Recommendation 1991/4 have been published by OSPAR. All Contracting Parties have been found to be applying BAT in the nuclear sector under PARCOM Recommendation 1991/4, which has in turn contributed to meeting the objectives of the OSPAR RSS under the NEAES 2010-2020.

Discharges of radioactive substances from the oil and gas sub-sector have mostly remained unchanged

For the oil and gas sub-sector, assessments have been carried out to determine whether there were progressive reductions over the period 2005 to 2018 and substantial reductions in discharges in the assessment period of 2012 to 2018 compared to the baseline period (2005 to 2011). The assessments carried out for the oil and gas sub-sector indicate that, in most cases, discharges of radioactive substances from the oil and gas sub-sector have remained unchanged. However, there is evidence that the discharge element of the first objective of the OSPAR RSS under the NEAES 2010-2020 has been fulfilled in some cases. Further, it should be noted that none of the assessments carried out for individual Contracting Parties revealed any actual increase in discharges.

Discharges from the other non-nuclear sub-sectors are not assessed, as either they are not significant contributors to discharged activities or there are uncertainties associated with the reported data and the amount entering the marine environment.

Best Available Techniques not available specifically for radioactive substances from the oil and gas sub-sector

For the oil and gas sub-sector, OSPAR Recommendation 2001/1 (as amended) requires the application of BAT to prevent pollution from oil and 'other substances' caused by discharges of produced water. While this Recommendation is not specific to radioactive substances, its implementation can result in reduced discharges of produced water and hence reduced discharges of naturally occurring radionuclides. In some circumstances, discharges of produced water from oil and gas installations can be reduced by re-injection. Re-injection as an option depends on a number of variables and not all production fields have sub-surface geology that would allow or accommodate the re-injection of produced water. Where produced water is routinely re-injected, the availability of the injection system can also result in periodic discharges of produced water.

Q4. How does this field affect the overall quality status?

Environmental concentrations are close to or lower than historic levels

From the assessments that OSPAR has carried out on environmental concentrations of indicator radionuclides for the nuclear sector there is clear evidence that the second objective of the OSPAR RSS under the NEAES 2010-2020 has been fulfilled or more than fulfilled in all of the cases except one. In these situations, therefore, it is clear that environmental concentrations in the assessment period are close to or lower than historic levels. Examples of environmental concentrations for the period 1995 to 2018 are given in **Figure 4**. In OSPAR RSC sub-region 3[2], the statistical assessment showed evidence of an increase in environmental concentrations of H-3 in seawater between the assessment and baseline periods, which probably reflects the influence of the tritium discharges from the French nuclear fuel reprocessing facility at la Hague in OSPAR RSC sub-region 2. OSPAR has recognised in previous periodic evaluations that the industrial scale abatement of tritium in the liquid effluent of nuclear power stations and nuclear reprocessing facilities is currently not technically feasible.

[2] OSPAR RSC agreed to split the OSPAR Maritime Area into 15 sub-regions, taking into account specific sources, prevailing currents and the areas used in the MARINA II study. These 15 OSPAR RSC sub-regions generally represent subdivisions of the five main regions of the OSPAR Maritime Area, although some of the boundaries do not coincide exactly. See Figure S.1.

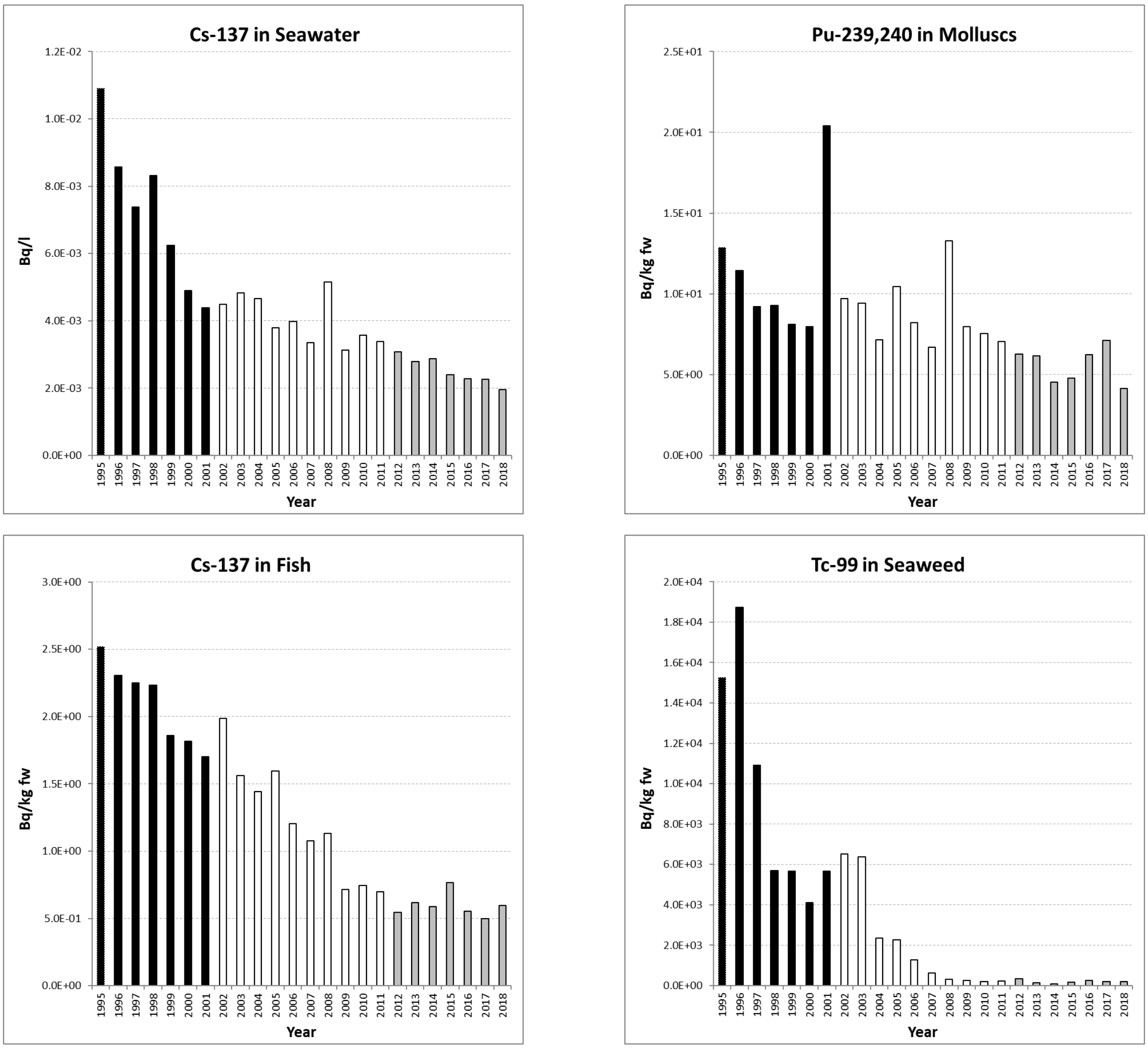


Figure 4. Examples of environmental concentrations for the period 1995 to 2018, showing Cs-137 in seawater in OSPAR RSC sub-region 10, Pu-239,240 in molluscs for OSPAR RSC sub-region 6, Cs-137 in fish for OSPAR RSC sub-region 12 and Tc-99 in seaweed for OSPAR RSC sub-region 6 (evidence of a reduction in all cases). Time periods indicated are baseline period 1995-2001 (black columns), assessment period 2012-2018 (grey columns) and intervening years (white columns). Note, different scales are used for the vertical axes in the examples above.

No significant radiological impact from environmental concentrations

OSPAR has carried out assessments to determine the radiological impact of mean values of environmental concentrations of indicator radionuclides for the nuclear sector (H-3, Tc-99, Cs-137 and Pu-239,240) in seawater in the assessment period. In all cases except one the annual doses from the indicator radionuclides would be a fraction of those corresponding to the relevant environmental reference levels. This would not result in a significant radiological impact on humans or the marine environment. This includes the situation in OSPAR RSC sub-region 3, where there was evidence of an increase in environmental concentrations of H-3 in seawater between the assessment and baseline periods. The impact of the environmental concentration of H-3 in the OSPAR Maritime Area is far lower than the trivial dose. The one case where the OSPAR methodology did not conclude that the impact was trivial, was for Pu-239,240 in seawater in OSPAR RSC sub-region 6. However, more focused assessments carried out by the United Kingdom have concluded that the radiological impacts resulting from Pu-239,240 in seawater in OSPAR RSC sub-region 6 are very low.

OSPAR has also carried out assessments to determine the radiological impact of modelled additional concentrations of indicator radionuclides for produced water from the non-nuclear oil and gas sub-sector over the wider OSPAR Maritime Area. In all cases the annual doses from the additional concentrations of these indicator radionuclides in seawater would be a fraction of those corresponding to relevant environmental reference levels. Again, this would not result in a significant radiological impact on humans or the marine environment.

Q5. What do we do next?

Preventing pollution of the OSPAR Maritime Area is an ongoing task

Contracting Parties have successfully fulfilled the objectives of the OSPAR RSS for 2020 under the NEAES 2010-2020 and have made significant progress towards fulfilling *the ultimate aim of concentrations in the environment near background values for naturally occurring radioactive substances and close to zero for artificial radioactive substances.* In doing so, Contracting Parties have prevented pollution of the OSPAR Maritime Area by ionising radiation. However, delivering the aims of the OSPAR Convention is an ongoing task. Therefore, new strategic and operational objectives for radioactive substances were agreed by the Ministerial Meeting of the OSPAR Commission 2021 in Cascais, Portugal, under the North-East Atlantic Environment Strategy 2030. Under the theme of Clean seas, the new strategic objective for radioactive substances states that:

OSPAR will prevent pollution by radioactive substances in order to safeguard human health and to protect the marine environment with the ultimate aim of achieving and maintaining concentrations in the marine environment at near background values for naturally occurring radioactive substances and close to zero for human made radioactive substances.

This work will be carried forward through the delivery of the following operational objectives:

S3.O1: On an ongoing basis OSPAR will further prevent, progressively reduce or, where that is not practicable, minimise discharges of radioactive substances through the application of Best Available Techniques (BAT), taking into account technical feasibility, radiological impact and legitimate uses of the sea.

S3.O2: By 2025 OSPAR will identify and consider any obstacles in achieving further reductions in environmental concentrations of radioactive substances in the marine environment and examine possible solutions where appropriate.

S3.O3: By 2025 OSPAR will identify the different types of loss of radioactive substances that may contribute to pollution of the marine environment. By 2027 OSPAR will determine if any additional measures are required to prevent such pollution, to the extent that such pollution is not already the subject of effective measures agreed by other international organisations or prescribed by other international conventions.

S3.O4: By 2028 OSPAR will, following the outcome of the Quality Status Report 2023, address, where appropriate, any uncertainties by reviewing and updating methodologies to better determine the possible impact of releases, emissions and losses of radioactive substances on marine ecosystems.

As an addition operational objective (S10.O3), OSPAR has agreed *to assess the current and projected impacts of climate change and ocean acidification on the OSPAR Maritime Area and its uses, to inform the development of national and international actions*. For radioactive substances this work will influence the review of the currently agreed assessment methodologies and the data and parameters upon which these methodologies rely.

Table 1: Summary table for radioactive substances

Region	Overall change in discharges	Overall change in environmental activity concentration of assessed radionuclides	Key factors and pressures (now and for the future)	Outlook for pressures	Action needed
Arctic Waters (Region I)	Nuclear industry: not applicable Offshore oil/gas industry: ←→	↓	Dispersion of discharges from the nuclear industry from Regions II and III Discharges from oil and gas extraction in Region I Dispersion of discharges from oil and gas extraction in Regions II and III Dispersion of Chernobyl fallout Climate change	Further reduction of discharges from the nuclear sector Increasing climate change impacts	Continued monitoring and assessment by OSPAR Continued use of OSPAR measures Research into climate change impacts
Greater North Sea (Region II)	Nuclear industry: ↓ Offshore oil/gas industry: ←→	↓	Discharges from the nuclear industry in Region II Dispersion of discharges from the nuclear industry from Region III Discharges from oil and gas extraction in Region II Dispersion of Chernobyl fallout Climate change	Further reduction of discharges from the nuclear sector Increasing climate change impacts	Continued monitoring and assessment by OSPAR Continued use of OSPAR measures Research into climate change impacts
Celtic Seas) Region III	Nuclear industry: ↓ Offshore oil/gas industry: ←→	↓	Discharges from the nuclear industry in Region III Discharges from oil and gas extraction in Region III Climate change	Further reduction of discharges from the nuclear sector Increasing climate	Continued monitoring and assessment by OSPAR Continued use of OSPAR measures Research into climate change impacts

				change impacts	
Bay of Biscay and Iberian Coast (Region IV)	Nuclear industry: ↓ Offshore oil/gas industry: not applicable	↓	Discharges from the nuclear industry in Region IV Climate change	Further reduction of discharges from the nuclear sector Increasing climate change impacts	Continued monitoring and assessment by OSPAR Continued use of OSPAR measures Research into climate change impacts
Wider Atlantic (Region V)	Not applicable	No data	Dispersion of discharges from the nuclear industry in Regions II and III Climate change	Increasing climate change impacts	Research into climate change impacts

D - Driver(s)

The social and economic driving forces behind the human activities leading to inputs of radioactive substances into the marine environment

Society's need for energy, industrial processes, health and wellbeing and national security have resulted in past and present human activities that have led to the introduction of radionuclides to the marine environment.

Figure D.1: Nuclear plant in Germany

- ***Society's need for energy***

Society and the economy are dependent on reliable energy supplies. Both the nuclear sector and the oil and gas sub-sector, which contribute to the energy mix of Contracting Parties, result in discharges of radioactive substances to the OSPAR Maritime Area.

- ***Society's need to mitigate the effects of climate change***

There is a recognised need to urgently reduce greenhouse gas emissions. Some Contracting Parties consider that nuclear technologies (nuclear fission and potentially nuclear fusion) have a role to play in fulfilling this need and have national policies that include the use of nuclear energy to aid decarbonisation ambitions.

- ***Society's need for industrial processes***

Activities and associated infrastructure on land for industrial uses, including manufacturing, processing and storage of raw materials. Industrial activities within the non-nuclear sector can result in discharges of radioactive substances to the OSPAR Maritime Area.

- ***Society's need for health and wellbeing***

Radioactive substances used for therapeutic and diagnostic purposes can lead to discharges of radioactive substances to the OSPAR Maritime Area.

- ***Society's need for national security***

Radioactive substances are used in various military applications to contribute to national security and defence.

A – Activity(ies)

The human activities leading to inputs of radioactive substances into the marine environment

The main ongoing human activities that lead to the inputs of radioactive substances into the OSPAR Maritime Area are the nuclear sector and the oil and gas sub-sector. The intensity of these activities varies across the five main OSPAR Regions, with the highest intensity in Region II (Greater North Sea) and Region III (Celtic Seas).

Table A.1: Chapter Summary per OSPAR Region

Activities	Arctic Waters (Region I)	Greater North Sea (Region II)	Celtic Seas (Region III)	Bay of Biscay and Iberian Coast (Region IV)	Wider Atlantic (Region V)
Nuclear sector					
Relative intensity[1]	L[2]	H	H	M	N/A
Trend since QSR 2010[3]	↔	↓	↓	↔	N/A

Expected trend to 2030[3]	↔	↔	↔	↔	N/A
Oil and gas sub-sector[4]					
Relative intensity[1]	M	H	M	L	L
Trend since QSR 2010	↔	↔	↔	↔	↔
Expected trend to 2030	↔	↔	↔	↔	↔

1 - Relative for the OSPAR Maritime Area.

2 - Reflects Russian civilian nuclear sector activities that result in inputs of radionuclides to Region I.

3 - Trends since QSR 2010 and expected trends to 2030 consider the type and number of facilities, and whether facilities are operational or undergoing decommissioning activities.

4 - Assessment by the Offshore Industry Committee. Valid for the all the three rows below the "Oil and Gas sector" section.

- ***Production of energy***

  In 2021, the 82 nuclear sites in operation or undergoing decommissioning in the OSPAR catchment area comprised: nuclear power plants, which harness the heat produced in nuclear reactions and convert this to electrical energy; nuclear fuel reprocessing plants, which recycle used nuclear fuel to recover uranium and plutonium; nuclear fuel fabrication and enrichment plants, which provide the uranium fuel for the power plants; and research and development facilities relating to all aspects of the nuclear sector and which can include the production of radionuclides for medical or industrial purposes.
  All nuclear facilities produce discharges that are authorised and are subject to regulatory limits and conditions by national authorities, with liquid discharges either entering the marine environment directly or via rivers that drain into the sea.
- ***Extraction of oil and gas, including infrastructure***

  The extraction of oil and gas also results in the discharge of produced water containing naturally occurring radioactive substances into the OSPAR Maritime Area. The removal of scale material from oil and gas equipment can also lead to the discharge of naturally occurring radioactive substances into the OSPAR Maritime Area.

- ***Industrial uses***

  The non-nuclear radiochemical production, phosphate production, titanium dioxide pigment manufacture, primary steel manufacture and rare earth mineral production sub-sectors all give rise to liquid discharges of radioactive substances, which are reported to OSPAR.

- ***Research, survey and educational activities***

  Activities within the university and research centre sub-sector can lead to discharges of radioactive substances into the OSPAR Maritime Area.
- ***Medical uses***

  Hospitals that use short-lived radioactive substances for therapeutic and diagnostic purposes are authorised to discharge such substances, which are mainly contained in patient excreta.
- ***Security/defence***

  Radioactive substances may be used by the military sector and discharges of radioactive substances may occur during the development, testing, construction, operation and decommissioning of any military equipment that uses radioactive substances. Some states have nuclear propulsion and nuclear weapons programmes. Examples of inputs of radioactive substances to the environment from such activities include historic nuclear weapons testing and the loss at sea of nuclear-powered submarines.

P – Pressure(s)

The input of radioactive substances to the marine environment

The main contributions to the pressure that results from inputs of radioactive substances to the marine environment are the authorised discharges from the nuclear sector and the oil and gas sub-sector. The intensity of these discharges varies across the five OSPAR Regions, with the highest intensity in Region II (Greater North Sea) and Region III (Celtic Seas). Discharges from the nuclear sector have shown progressive and substantial reductions, while discharges of radioactive substances from the oil and gas sub-sector have mostly remained unchanged. A further contribution to this pressure comes from historic discharges from the same activities, as well as from other events such as the Chernobyl accident and fallout from nuclear weapons testing in the 1950s and 1960s.

Table P.1: Chapter Summary per OSPAR Region

Pressures	Arctic Waters (Region I)	Greater North Sea (Region II)	Celtic Seas (Region III)	Bay of Biscay and Iberian Coast (Region IV)	Wider Atlantic (Region V)
Discharges from the nuclear sector					
Relative intensity[1]	M	H	H	M	L
Trend since QSR 2010[2]	↓	↓	↓	↔	↔

Expected trend to 2030[3]	↓	↔	↓	↔	↔
Discharges from the oil and gas sub-sector					
Relative intensity[4]	M	H	M	L	L
Trend since QSR 2010[5]	↔	↔	↔	↔	↔
Expected trend to 2030	↔	↔	↔	↔	↔

1 - Relative for the OSPAR Maritime Area and based on discharge data reported to OSPAR up to 2018 and published in the Fifth Periodic Evaluation. Although there are no direct discharges from the nuclear sector to OSPAR Region V, discharges from the nuclear sector to other OSPAR Regions can be transported by ocean currents to OSPAR Region V. The relative intensity for OSPAR Region V is therefore based on expert judgement in relation to the intensity of the pressure of discharges from the nuclear sector to the other OSPAR Regions.

2 - Trends since the QSR 2010 are based on the assessments carried out by OSPAR in the Fifth Periodic Evaluation, with the exception of OSPAR Region V which is based on expert judgement (see footnote 1).

3 - Expected trends to 2030 consider the type and number of facilities, and whether facilities are operational or undergoing decommissioning activities. Expected trend for OSPAR Region V is based on expert judgement (see footnote 1).

4 - Relative for the OSPAR Maritime Area and based on discharge data reported to OSPAR up to 2018 and published in the Fifth Periodic Evaluation.

5 - Trends since the QSR 2010 are based on the assessments carried out by OSPAR in the Fifth Periodic Evaluation.

- ***Input of radioactive substances***

  There are ongoing pressures from the discharge of radioactive substances as a result of the normal operation of nuclear facilities, oil and gas platforms and some other non-nuclear industries as well as from medical uses.

  - ***Input of radioactive substances from the nuclear sector***

  Radionuclides present in liquid effluents from nuclear power stations vary depending upon the type of reactor. However, in general, these effluents contain quantities of fission products such as caesium-137 (Cs-137), and activation products such as cobalt-60 (Co-60) (which are beta/gamma emitters). Sometimes, they also contain very low levels of alpha-emitting radionuclides such as plutonium-239 and plutonium-240 (Pu-239,240). In addition, nuclear power stations are a significant contributor to discharges of tritium (H-3), a weak beta emitter. The sources of these discharges include the reactor, the coolant and associated systems, and the fuel storage ponds. Effluents are typically routed via treatment plants to reduce the levels of radioactivity before discharge.

Nuclear fuel reprocessing results in authorised discharges to the environment from a range of sources such as fuel storage ponds, reprocessing plants and associated downstream plants, and legacy waste management and decommissioning. The radionuclides discharged include H-3, carbon-14 (C-14), beta-gamma emitters such as Co-60, strontium-90 (Sr-90), technetium-99 (Tc-99), ruthenium-106 (Ru-106) and Cs-137, and alpha emitters such as Pu-239,240 and americium-241 (Am-241).

Liquid discharges from the nuclear fuel fabrication and enrichment sub-sector largely consist of uranium isotopes and their decay products, as well as other radionuclides such as Tc-99 if certain types of feed material, such as uranium from reprocessing, have been used.

Liquid discharges from the nuclear research and development sub-sector are typically lower than the other sub-sectors. In some cases, the range of individual radionuclides reported is relatively large, but the principal radionuclides tend to be those found in discharges from the nuclear power sub-sector.

OSPAR has carried out assessments of indicators for each nuclear sub-sector (for individual Contracting Parties where discharges from these sub-sectors occur to the OSPAR Maritime Area and the sum of all such discharges) as well as for the nuclear sector as a whole (the sum of all such discharges from all sub-sectors). From the assessments carried out by OSPAR on data for the period 1995 to 2018 there is clear evidence that in the majority of cases for the nuclear sector there have been progressive and substantial reductions in discharges. Further, it should be noted that no assessments revealed any actual increase in discharges across the nuclear sector.

- ***Input of radioactive substances from the non-nuclear sector***

The main source of radionuclides from the oil and gas sub-sector to the marine environment is through the discharge of produced water. Produced water is a by-product of the extraction of oil and gas that can comprise a mixture of formation water (i.e. water found naturally in the same formation as the oil or gas) and seawater that has been injected into the reservoir to maintain reservoir pressure. The radioactive content of produced water arises from naturally occurring radionuclides contained in the reservoirs and includes lead-210 (Pb-210), radium-226 (Ra-226) and radium-228 (Ra-228).

From the assessments carried out by OSPAR on data for period 2005 to 2018 for the oil and gas sub-sector there is evidence of some progressive and substantial reductions in discharges. However, in most cases discharges of radioactive substances from this sub-sector have remained unchanged. Further, none of the assessments carried out for individual Contracting Parties revealed any actual increase in discharges.

For the medical sub-sector, the main radionuclide discharged is iodine-131 (I-131), with a half-life of eight days. The use of decay tanks in some countries has notably reduced the discharge of I-131. Due to uncertainties associated with the reported data and the amount entering the marine environment, OSPAR has agreed not to carry out any assessments of the discharges from this sub-sector at present. However, OSPAR is continuing to review the work of individual Contracting Parties on the issues surrounding the discharge of this radionuclide.

Several Contracting Parties report data to OSPAR for a number of other non-nuclear sub-sectors. From the data reported for the university and research centre sub-sector, it is reasonable to conclude that this sub-sector is not a significant contributor to total beta (excluding tritium) or tritium discharges and that there are no alpha discharges.

Radiochemical production is carried out in several Contracting Parties, but the discharges from this sub-sector are in some cases included with those from the nuclear research and development sub-sector due to co-location of sites. Discharges of naturally occurring radionuclides have been reported by some Contracting Parties for phosphate production, titanium dioxide pigment manufacture, primary steel manufacture and rare earth mineral production. From the data reported to OSPAR it is reasonable to conclude that these sub-sectors are no longer a significant contributor to total alpha and total beta (excluding tritium) discharges.

- ***Other inputs and factors controlling the level of radioactive substances in the marine environment***

Radionuclides that are soluble in seawater are typically dispersed away from their discharge points by tidal and prevailing ocean currents. Radionuclides that are less soluble typically bind to sediments in the areas around their discharge points, where they can accumulate over time. The process by which such radionuclides bind to sediments can be dynamic, meaning that these radionuclides can be released or remobilised back into the overlying seawater. Through such processes, radionuclides that have accumulated in sediments as the result of previous higher discharge levels can act as a significant source of these radionuclides over time, particularly where discharge levels have subsequently been reduced.
It is important to note that not all radionuclides present in the environment are the result of authorised discharges from the nuclear and non-nuclear sectors. There have been a number of accidents and events, such as the Chernobyl accident in 1986 and fallout from atmospheric nuclear weapons testing in the 1950s and 1960s, which resulted in the introduction of radionuclides to the marine environment. Indeed, any accident situation in the future involving the release of radioactive substances may lead to increased levels of radionuclides in the marine environment over and above those resulting from current discharges.

Other industrial activities have also released radionuclides into the marine environment as a consequence of their processes. In many cases, the additional sources of radionuclides from these historical accidents and events are still detectable today and will generally be indistinguishable from past and contemporary discharges of radionuclides. For this reason, monitoring data for environmental concentrations of radioactive substances reflect the sum of contributions from historical accidents and events and past and contemporary discharges of radionuclides. In addition, environmental concentrations of naturally occurring radionuclides by definition will also contain natural background levels of these radionuclides.

Table P.2: Statement on confidence assessment for conclusions on the pressure from discharges of radioactive substances from the nuclear sector and the oil and gas sub-sector[1]

Confidence	Arctic Waters (Region I)	Greater North Sea (Region II)	Celtic Seas (Region III)	Bay of Biscay and Iberian Coast (Region IV)	Wider Atlantic (Region V)
Discharges from the	Very high	Very high	Very high	Very high	Very high

nuclear sector					
Discharges from the oil and gas sub-sector	Very high	Very high	Very high	Very high	Very high

1 - Confidence assessments are based on trends since the QSR 2010 (see summary table) as these are based on discharge data reported by Contracting Parties and assessments carried out by OSPAR in the Fifth Periodic Evaluation. Conclusions made by OSPAR as to the progressive and substantial nature of any reductions in discharges are based on the statistical significance of the relevant assessment methodologies.

S – State

Environmental concentrations of radionuclides in the OSPAR Maritime Area and their radiological impact

The description of the state of the marine environment in relation to radioactive substances is based on the outcome of the OSPAR assessments that cover environmental concentrations, and radiological impact. For environmental concentrations of indicator radionuclides for the nuclear sector there is clear evidence that environmental concentrations in the assessment period are close to or lower than historic levels. The environmental concentrations of indicator radionuclides for the nuclear sector in seawater would not result in a significant radiological impact on humans or the marine environment. In addition, the modelled additional concentrations of indicator radionuclides for produced water from the non-nuclear oil and gas sub-sector in seawater would not result in a significant radiological impact on humans or the marine environment.

Table S.1: Chapter Summary per OSPAR Region

State	Arctic Waters (Region I)	Greater North Sea (Region II)	Celtic Seas (Region III)	Bay of Biscay and Iberian Coast (Region IV)	Wider Atlantic (Region V)
Environmental concentrations					
Intensity[1]	L	L	L	L	L
Trend since QSR 2010[2]	↓	↓	↓	↓	↓
Expected trend to 2030	↓	↔	↓	↔	↓
Radiological impact					

Intensity[3]	L	L	L	L	L
Trend since QSR 2010[2]	↓	↓	↓	↓	↓
Expected trend to 2030	↓	↔	↔[4]	↔	↓

1 - Intensity of environmental concentrations is based on data reported to OSPAR up to 2018 and published in the Fifth Periodic Evaluation. No Contracting Party reports environmental concentration data to OSPAR for OSPAR Region V, but it is possible to comment on the intensity for OSPAR Region V based on expert judgement and published data from other sources.

2 - Trends since QSR 2010 are based on assessments carried out by OSPAR in the Fifth Periodic Evaluation. Trend for OSPAR Region V is based on expert judgement and published data from other sources (see footnote 1).

3 - Intensity of radiological impact is based on the assessments carried out by OSPAR in the Fifth Periodic Evaluation. Radiological impact for OSPAR Region V is based on expert judgement and published data from other sources (see footnote 1).

4 - Although activity concentrations of three (H-3, Tc-99 and Cs-137) out of four indicator radionuclides for the nuclear sector are expected to reduce further, the radiological impact from all four indicator radionuclides is expected to be similar due to the remobilisation of Pu-239,240 from the inventory of this radionuclide in sediments as the result of historic discharges and the significant radiological impact it produces.

- ***The levels of radionuclides in the marine environment***

  From the assessments that OSPAR has carried out on data for the period 1995 to 2018 for environmental concentrations of indicator radionuclides associated with the nuclear sector, there is clear evidence that environmental concentrations in the assessment period are close to or lower than historic levels. In OSPAR RSC sub-region 3, the statistical assessment showed evidence of an increase in environmental concentrations of H-3 in seawater between the assessment and baseline periods which probably reflects the influence of the tritium discharges from the French nuclear fuel reprocessing facility at la Hague in OSPAR RSC sub-region 2. OSPAR has recognised in previous periodic evaluations that the industrial-scale abatement of tritium in the liquid effluent of nuclear power stations and nuclear reprocessing facilities is currently not technically feasible.

Table S.2: Assessment results for H-3, Tc-99, Cs-137 and Pu-239,240 in seawater by OSPAR RSC sub-region and OSPAR Region

OSPAR Region	OSPAR RSC sub-Region	Comparison against historic levels			
		H-3	Tc-99	Cs-137	Pu-239,240
Arctic Waters (Region I)	13	-	L	L	L
	14	-	C	L	L
	15	-	C	L	C
Greater North Sea (Region II)	2	L	-	-	C
	3	H	-	-	-

	7	C	-	L	L
	8	C	-	L	C
	9	C	-	L	L
	10	L	L	L	L
	11	-	-	L	C
	12	C	-	L	-
Celtic Seas) Region III	1	C	-	-	-
	4	-	-	L	-
	5	C	L	L	-
	6	L	L	L	C
	7	C	-	L	L
Bay of Biscay and Iberian Coast (Region IV)	1	C	-	-	-

L Lower than historic levels; C Close to historic levels; H Higher than historic levels; - No statistics possible. For further information on the assessment methodology and reasons for why no statistics were possible for some reasons see the [Fifth Periodic Evaluation](). No data available for Region V.

Table S.3: Assessment results for Tc-99, Cs-137 and Pu-239,240 in seaweed (S), molluscs (M) and fish (F) by OSPAR RSC sub-region and OSPAR Region

OSPAR Region	**OSPAR RSC sub-Region**	**Comparison against historic levels**								
		Tc-99			**Cs-137**			**Pu-239,240**		
		S	**M**	**F**	**S**	**M**	**F**	**S**	**M**	**F**
Arctic Waters (Region I)	13	L	-	-	L	-	C	-	-	-
	14	L	-	-	C	-	L	-	-	-
	15	L	-	-	C	-	L	-	-	-
Greater North Sea (Region II)	2	-	-	-	L	-	C	-	L	-
	3	L	-	-	L	-	L	-	C	-
	7	L	-	-	L	-	-	-	L	-
	8	-	-	-	-	-	-	-	C	-
	9	-	-	-	-	-	L	-	-	-
	10	L	-	-	L	L	L	-	L	-
	11	L	-	-	L	-	-	-	-	-
	12	L	-	-	L	-	L	-	-	-
	1	-	-	-	L	-	-	-	-	-

Celtic Seas) Region III	4	L	L	-	L	L	-	-	L	-
	5	L	-	-	L	L	L	C	C	-
	6	L	L	L	L	L	L	L	L	C
	7	L	-	-	L	-	-	-	L	-
Bay of Biscay and Iberian Coast (Region IV)	1	-	-	-	L	-	-	-	-	-

L - Lower than historic levels; C - Close with historic levels; - No statistics possible. For further information on the assessment methodology and reasons for why no statistics were possible for some reasons see the [Fifth Periodic Evaluation](). No data available for Region V.

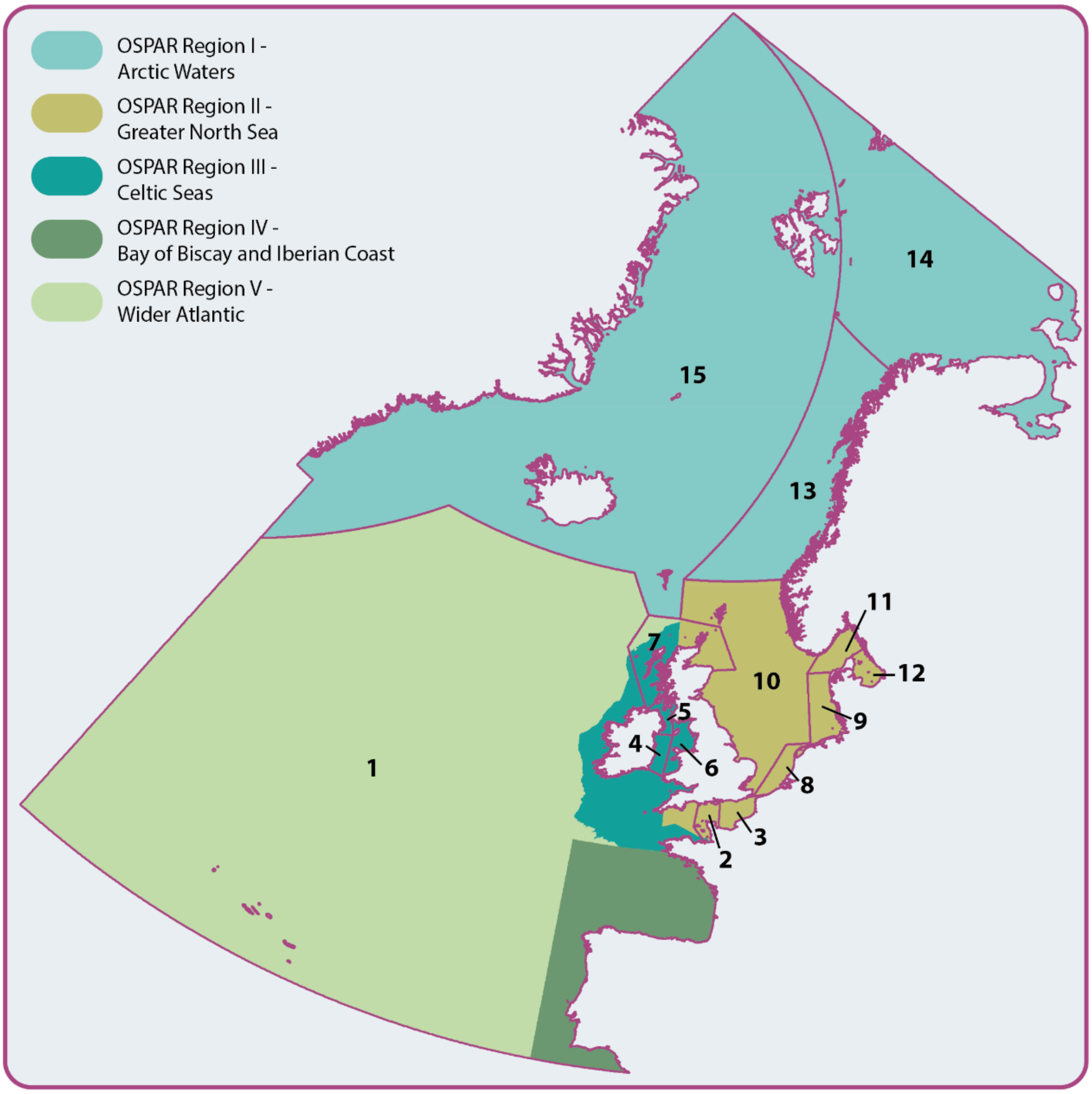


Figure S.1: Comparison of established OSPAR RSC sub-regions and the five main regions of the OSPAR maritime area. The 15 OSPAR RSC sub regions are: 1. Wider Atlantic, 2. Cap de la Hague Channel, 3. Channel East, 4. Irish Sea (Rep. of Ireland), 5. Irish Sea (Northern Ireland), 6. Irish Sea, 7. Scottish waters, 8. North Sea South (Belgian and Dutch Coast), 9. German Bight, 10. North Sea (NW, SE, and Central), 11. North Sea (Skagerrak), 12. Kattegat, 13. Norwegian Coastal Current, 14. Barents Sea and 15. Norwegian, Greenland Seas and Icelandic Waters.

- ***The radiological impact on humans and the marine environment***

  OSPAR has carried out assessments to determine the radiological impact of mean values of environmental concentrations of indicator radionuclides for the nuclear sector (H-3, Tc-99, Cs-137 and Pu-239,240) in seawater in the assessment period. In all cases except one the annual doses from the indicator radionuclides would be below the environmental reference levels and the trivial annual dose of 10 µSv. This would not result in a significant radiological impact on humans or the marine environment. This includes the situation in OSPAR RSC sub-region 3 where there was evidence of an increase in environmental concentrations of H-3 in seawater between the assessment and baseline periods. The impact of the environmental concentration of H-3 in the OSPAR Maritime Area is far lower than the trivial dose. The one case where the OSPAR methodology did not conclude that the impact was trivial, was for Pu-239,240 in seawater in OSPAR RSC sub-region 6. However, more focused assessments by the United Kingdom showed that the annual doses to the public from plutonium isotopes in seawater in OSPAR RSC sub-region 6 are approximately 10 µSv and that the maximum dose to the worst affected marine organism (phytoplankton) was approximately 25% of the reference dose value for phytoplankton used in the Fifth Periodic Evaluation. These assessments confirmed that the radiological impacts resulting from Pu-239,240 in seawater in OSPAR RSC sub-region 6 are very low. OSPAR has also carried out assessments to determine the radiological impact of modelled additional concentrations of indicator radionuclides for produced water from the oil and gas sub-sector over the wider OSPAR Maritime Area. In all cases the annual doses from the additional concentrations of these indicator radionuclides in seawater would be below the environmental reference levels and the trivial annual dose of 10 µSv. Again, this would not result in a significant radiological impact on humans or the marine environment.

Table S.4: Statement on confidence assessment for conclusions on the state for environmental concentrations of radioactive substances and radiological impact[1]

Confidence	Arctic Waters (Region I)	Greater North Sea (Region II)	Celtic Seas (Region III)	Bay of Biscay and Iberian Coast (Region IV)	Wider Atlantic (Region V)
Environmental concentrations	Very high	Very high	Very high	Very high	Very high
Radiological impact[2]	High	High	High	High	High

1 - Confidence assessments are based on intensity and trends since the QSR 2010 (see summary table) as these are based on environmental concentration data reported by Contracting Parties and assessments carried out by OSPAR in the Fifth Periodic Evaluation. Conclusions made by OSPAR as to whether environmental concentrations are close to (or lower than) historic levels are based on the statistical significance of the assessment methodology.

2 - Although OSPAR concludes that in all cases except one the annual doses from the indicator radionuclides would not result in a significant radiological impact on humans or the marine environment, OSPAR recognises that the

conclusions are based only on a select number of radionuclides and therefore assigns a confidence assessment of high to these conclusions.

I – Impact (on Ecosystem Services)

The impact on ecosystem services from current levels of radionuclides in the OSPAR Maritime Area

There are no impacts on ecosystem services from the current levels of radionuclides in seawater and marine biota in the OSPAR Maritime Area, with the exception of two localised areas in the United Kingdom that are the result of historic events.

- ***No impact on ecosystem services from current levels of radionuclides in the OSPAR Maritime Area***

  As previously stated, OSPAR has carried out assessments of the radiological impact of environmental concentrations of indicator radionuclides for the nuclear sector in seawater and modelled additional concentrations of indicator radionuclides for produced water for the oil and gas sub-sector in seawater. In all cases except one (see text under State) the annual doses from these indicator radionuclides would be below the environmental reference levels and the trivial annual dose of 10 µSv. This would not result in a significant radiological impact on humans or the marine environment. Therefore, there is no scientific evidence for any impacts on ecosystem services from the current levels of radionuclides in the OSPAR Maritime Area.

  However, it should be acknowledged that views may exist on impacts to ecosystem services related to cultural services such as spiritual, artistic, and symbolic services as well as ecosystem and species appreciation, as a result of human activities that lead to the input of radionuclides to the marine environment.

  OSPAR is aware that there are two localised areas in the United Kingdom (Dounreay and Dalgety Bay) where national authorities have undertaken assessments of radionuclides in the marine environment and as a result have put measures in place which impact ecosystem services by prohibiting the collection of seafood and curtailing recreational activities. For Dounreay, this is because of the presence of radioactive particles released, without authorisation, into the marine environment in the 1960s and 1970s from the now decommissioned Dounreay nuclear reprocessing facility. For Dalgety Bay, it is thought that the contamination originates from radium-coated instrument panels of military aircraft that were disposed of in the area at the end of World War II. Remedial action is underway at both locations.

- ***Potential economic and societal effects of increased levels of radionuclides in the marine environment***
  In the event of any increases in environmental concentrations, economic and societal impacts can occur even if the increases remain below national and international guidance on intervention levels for foods or any exposure pathways. Domestic and export markets for fishery industries are particularly sensitive to even the possibility of any contamination by radioactive substances. Societal impacts in situations where there is an increase in environmental concentrations could include reluctance to use coastal areas and amenities for fear of exposure to levels of radioactive substances through, for example, beach use, swimming or boating.

  One possible source of increased levels of radionuclides in the marine environment are the consequences of accidents involving radioactive material. Requirements to prevent accidental releases, and to mitigate their impact should they occur, are the subject of other conventions, notably the Convention on Nuclear

Safety, and relevant measures are implemented by Contracting Parties that are also signatories to the OSPAR Convention.

R – Response

The OSPAR Convention and other international guidance and recommendations

Since its conception, OSPAR has been concerned with pollution of the marine environment by radioactive substances and has developed the necessary measures over time, in parallel with actions by national authorities, to ensure progress in meeting the objectives of the OSPAR Radioactive Substances Strategy. The OSPAR Convention also recognises the need to take into account the recommendations of appropriate international organisations and agencies when adopting any programmes or measures on radioactive substances.

- ***Policy***

  At the first Ministerial Meeting of the OSPAR Commission, held in 1998 at Sintra, Portugal, a complete and permanent ban on all dumping of radioactive waste and other matter was agreed (OSPAR Decision 1998/2). Agreement was also reached on objectives to protect the marine environment of the North-East Atlantic against radioactive substances arising from human activities. These objectives were reaffirmed at subsequent Ministerial Meetings of the OSPAR Commission (Bremen 2003, Bergen 2010) and continued as the objectives of the OSPAR Radioactive Substances Strategy (RSS) under the North-East Atlantic Environment Strategy (NEAES) 2010-2020. These objectives state that:
  1.1 The OSPAR Commission's strategic objective with regard to radioactive substances is to prevent pollution of the OSPAR Maritime Area from ionising radiation through progressive and substantial reductions of discharges, emissions and losses of radioactive substances, with the ultimate aim of concentrations in the environment near background values for naturally occurring radioactive substances and close to zero for artificial radioactive substances. In achieving this objective the following issues should, inter alia, be taken into account:
  a. radiological impacts on man and biota;
  b. legitimate uses of the sea;
  c. technical feasibility.
  1.2 The Radioactive Substances Strategy will be implemented progressively by making every endeavour, through appropriate actions and measures to ensure that by the year 2020 discharges, emissions and losses of radioactive substances are reduced to levels where the additional concentrations in the marine environment above historic levels, resulting from such discharges, emissions and losses, are close to zero.

  New strategic and operational objectives for radioactive substances were agreed by the Ministerial Meeting of the OSPAR Commission 2021 in Cascais, Portugal, under the NEAES 2030.

  OSPAR is a Regional Seas Convention that sits within a wider framework of other international conventions at the regional and global scale (e.g. the London Convention, the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management, the Convention on Nuclear Safety and the EU Nuclear Safety Directive (Council Directive 2009/71/Euratom)). Regarding radioactive substances, a number of international bodies provide authoritative advice on this topic, such as the International Commission on Radiological Protection (ICRP) and the International Atomic Energy Agency (IAEA). The importance of such advice is recognised in the OSPAR Convention, which requires Contracting Parties to take account of the recommendations of appropriate international organisations and agencies when adopting any programmes or measures for radioactive substances.

- ***Are these measures working?***

The OSPAR Radioactive Substances Committee (RSC) has successfully established the necessary monitoring and data reporting programmes and developed the necessary assessment methodologies in order to be able to determine whether the objectives of the OSPAR RSS under the NEAES 2010-2020 have been fulfilled. The measures developed by OSPAR, as well as action by national authorities, has ensured that progress could be made against these objectives. When taking into account the assessments carried out by OSPAR of discharges from the nuclear sector and non-nuclear sector and of environmental concentrations and their radiological impact, and any context provided, it can be concluded that Contracting Parties have successfully fulfilled the objectives of the OSPAR RSS for 2020 under the NEAES 2010-2020 and have made significant progress towards fulfilling the *ultimate aim of concentrations in the environment near background values for naturally occurring radioactive substances and close to zero for artificial radioactive substances*. In doing so, Contracting Parties have prevented pollution of the OSPAR Maritime Area by ionising radiation. The OSPAR Convention requires Contracting Parties to apply Best Available Techniques (BAT) and Best Environmental Practice (BEP) including, where appropriate, clean technology, in their efforts to prevent and eliminate marine pollution including radioactive discharges. In particular, national regulatory frameworks for the use of radioactive materials and the discharge of radioactive waste take into account the general principles of radiation protection: justification, optimisation, and dose limitations. All Contracting Parties have been found to be applying BAT in the nuclear sector under PARCOM Recommendation 1991/4, which has in turn contributed to meeting the objectives of the OSPAR RSS under the NEAES 2010-2020. For the oil and gas sub-sector, OSPAR Recommendation 2001/1 (as amended) requires the application of BAT to prevent pollution from oil and 'other substances' caused by discharges of produced water. While this Recommendation is not specific to radioactive substances, its implementation can result in reduced discharges of produced water through re-injection and hence reduced discharges of naturally occurring radionuclides.

- ***Services and benefits***

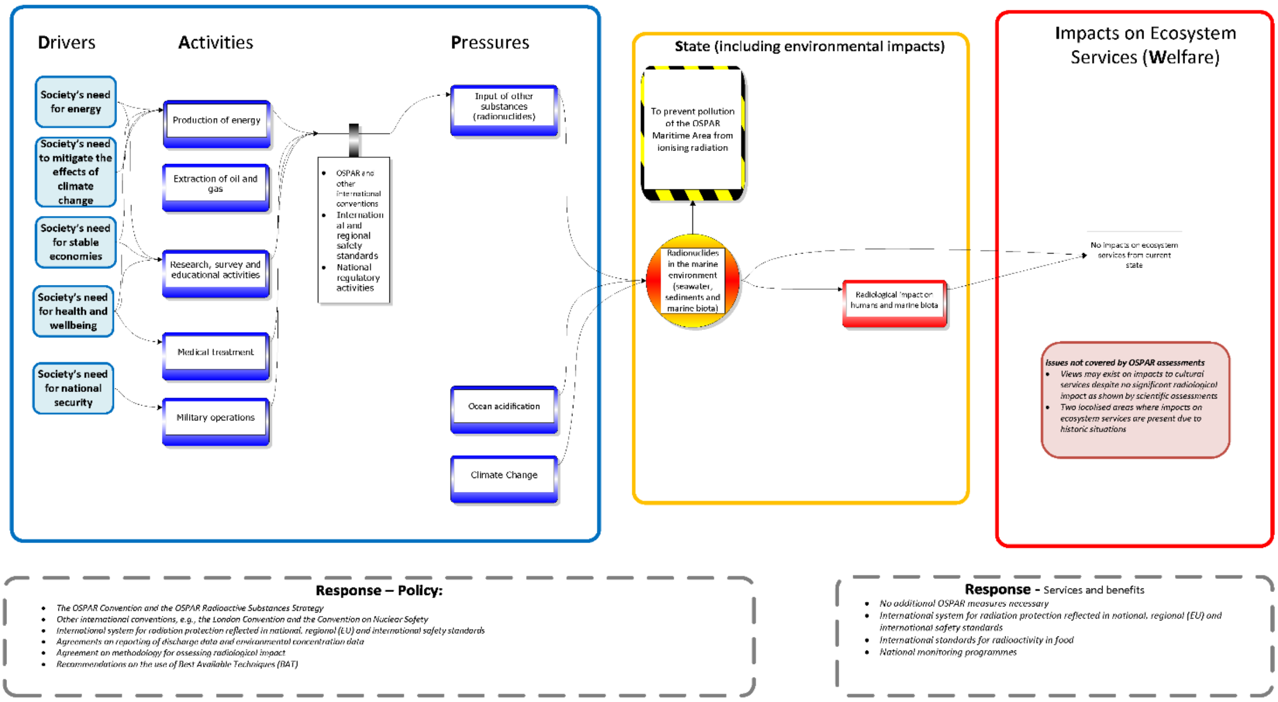
  There are no OSPAR measures in place which target services and benefits as a response to radioactive substances in the marine environment.

  Should circumstances warrant it, for example where radioactive substances in the marine environment (from historic practices or a nuclear emergency) are such that there are safety concerns associated with services and benefits (e.g. food production, leisure activities), there is an established international framework of standards and guidance to aid the selection of suitable protective measures. These measures could include restrictions on access, on fishery and aquaculture activities, and on the distribution of foodstuffs containing radioactive substances above specified levels.

  One of the reasons for national monitoring of radioactive substances in the marine environment is to provide reassurance to consumers of seafood that levels of radioactive substances are low and that seafood is safe for human consumption. For those Contracting Parties with nuclear facilities, national monitoring programmes typically provide information on doses from existing levels of radionuclides in the environment arising from various exposure pathways, for example beach use, in order to provide reassurance to the public that such areas are safe to use.

Bow-tie analysis

This thematic assessment has identified the inputs of radionuclides from a range of human activities It has concluded that there is no significant radiological impact from the current levels of radionuclides in seawater and marine biota in the OSPAR Maritime Area. The input of radionuclides is included as one of the collective pressures in the biodiversity thematic assessments.



Climate change

- ***Climate change***

  There is little evidence that climate change is having any impact on radioactive substances within the OSPAR Maritime Area at present. Increased levels of naturally occurring radionuclides in the Arctic Ocean have been linked to a reduction in the depth of permafrost and increased mobility of these radionuclides in soils (Kipp et al. 2018). However, there is a potential for predicted climate change effects (IPCC 2021) to influence many aspects of radioactive substances in the marine environment, and this could have an impact on the assessments currently being carried out by OSPAR as well as the underlying parameters to such assessments.

  Climate change may have the potential to affect the sources of radioactive substances to the OSPAR Maritime Area, owing to predicted increasing sea levels and storm surge events that may result in increased remobilisation of radionuclides from coastal sediments as well as threatening the safety of coastal nuclear facilities. Changing precipitation patterns, including more extreme precipitation events, that result in increased run-off could lead to greater inputs of radioactive substances from the terrestrial environment. Climate change impacts may lead to changes in the oceanic transport of discharged radionuclides that would then affect the distribution of radioactive substances in the OSPAR Maritime Area. Warming seas may affect the uptake of radionuclides by marine biota and food web structures leading to changes in the biological transfer of radionuclides.

- ***Ocean acidification***

  There is little evidence that ocean acidification is having any impact on radioactive substances within the OSPAR Maritime Area at present. However, ocean acidification may have the potential to affect the mobility of radionuclides in the marine environment and their uptake by marine biota through impacts on the availability of other compounds (e.g., organic ligands). Further, ocean acidification may affect the remobilisation of radionuclides from sediments due to changes in solution chemistry (e.g. pH).

Thematic Metadata

Field	Data Type	Explanation
Linkage	URL	IPCC, 2021. Climate Change 2021: The Physical Science Basis – Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Kipp, L.E., Charette, M.A., Moore, W.S., Henderson, P.B. and Rigor, I.G., 2018. Increased fluxes of shelf-derived materials to the central Arctic Ocean. Science Advances, 4(1), p.eaao1302.
Relevant OSPAR Documentation	Text	OSPAR Recommendation 2018/1 on Radioactive Discharges OSPAR Agreement 2018-01 Guidelines for the submission of Information about, and Assessment of, the Application of BAT and BEP in Nuclear Facilities OSPAR Agreement 2016-01 (2020 update) Coordinated Environmental Monitoring Programme (CEMP) OSPAR Agreement 2016-07 (2022 update) Methodology for Deriving Environmental Assessment Criteria and their application OSPAR Agreement 2014-02 (2021 update) Joint Assessment and Monitoring Programme (JAMP) 2014 – 2023. OSPAR Agreement 2013-10 (2021 update) Reporting Formats for the Collection of Data on Liquid Discharges from Nuclear Installations. OSPAR Agreement 2013-11 (2021 update) Reporting Procedures for Discharges of Radioactive Substances from Non-nuclear Sectors. OSPAR Agreement 2005-08 (2018 update) Agreement on a Monitoring Programme for Concentrations of Radioactive Substances in the Marine Environment Gwynn, J., Fievet, B., Stackhouse, A., Robinson, C., Aquilonius, K., Arends, P., Baglan, N., Caplin, H., Cardoso, G., Chartier, M., Claes, J., Dewar, A., Hagg, A., Löhle, J., Luque, S., McGinnity, P., Nilsen, M., Nyffenegger, C., Pynn, A., Reynal, N., Ryan, R., Siegfried, M., Tanzi, C.P., Telleria, D., Trinidad, J.A., 2022. *Fifth periodic evaluation of progress towards the objective of the OSPAR Radioactive Substances Strategy*. In: OSPAR, 2023: The 2023 Quality Status Report for the Northeast Atlantic. OSPAR Commission, London. Available at: https://oap.ospar.org/en/ospar-assessments/quality-status-reports/qsr-2023/other-assessments/5pe

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Our vision is a clean, healthy and biologically diverse North-East Atlantic Ocean, which is productive, used sustainably and resilient to climate change and ocean acidification.

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