SCALE UP
community-driven
bioeconomy development

Sustainability Screening Report – French Atlantic Arc, FR

March 2024

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EXECUTIVE SUMMARY

This report has been produced as part of the SCALE-UP project funded by the Horizon Europe research and innovation programme. The aim of this project is to support the development of small-scale bioeconomy solutions in rural areas across Europe. The aim of this study is to raise awareness of the ecological limits on the French Atlantic Arc, based on three resources: water, soil and biodiversity. The bioeconomy is by definition the economy of bioresources (from agriculture, forestry, aquaculture and biowaste), therefore of the living. It is essential to design bioeconomy sustainably, and that its development takes into account the potential impact on the environment. Furthermore, in the current context of fighting against climate change and environmental degradation, bioeconomy activities that provide environmental benefits (water quality, preservation of biodiversity, etc.) must be sought and encouraged. This report is therefore aimed at project leaders and stakeholders in the bioeconomy willing to develop an activity, to enable them to integrate these environmental considerations into the development of their strategy, product or service.

The French Atlantic Arc region for the SCALE-UP project corresponds to the four administrative regions of Brittany, Normandy, New-Aquitaine and Pays de la Loire. These regions correspond to the field of action of the Association of the Chambers of Agriculture of the Atlantic Area (AC3A), the French partner in the project. Agriculture is dominant in this large territory, with 144,000 farms (RGA 2020) covering an area of 89,656 km². This agriculture is very diverse, though dominated by livestock farming (2/3 of farms are predominantly livestock farms), and by field crops, which accounts for between 32% and 39% of the Utilised Agricultural Area (UAA). Another feature common to the four regions that make up the Atlantic Arc is the strong demographic pressure due to the region's proximity to the Atlantic seaboard and the English Channel. Finally, this large territory is fully affected by the impacts of climate change, with rising temperatures and significant pressure on water resources, soils and biodiversity. These considerations about climate change and its consequences need to be considered in the development of bioeconomy activities.

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Glossary

Agricultural land	It includes cultivated land (annual and market garden crops, permanent crops, temporary grassland, fallow land, etc.) and grassland used for livestock farming. (Source: AGRESTE)
Biodiversity	Biodiversity refers to all living organisms and the ecosystems in which they live. It also includes the interactions of species with each other and with their environment (Source: OFB).
Bioeconomy	The bioeconomy encompasses economic activities based on renewable resources: forestry, agriculture, aquaculture and biowaste. These activities are designed to provide a sustainable response to society's need for food and part of its need for materials and energy, while preserving the natural resources (agricultural, aquacultural and forestry biomass) of an area and guaranteeing the production of high-quality environmental services. (Source: French Ministry of Agriculture and Food)
Common generalist birds	Birds that tolerate a wide range of environmental conditions, can thrive in a variety of environments and make use of a wide range of resources. (Source: OFB)
Common specialist birds	Birds whose survival depends on specific environmental conditions and which can only be found in specific habitats such as farmland, built-up areas or forests (Source: OFB).
Ecological status of surface waters	The state of an aquatic ecosystem, making it possible to determine its structure and how well it functions on the basis of its fauna and flora, certain physico-chemical characteristics and its physical state (banks, dams, etc.). (Source: OFB)
Eutrophication	Excessive enrichment of watercourses and bodies of water with nutrients such as phosphorus and nitrogen, which act as fertiliser for aquatic plants. Eutrophication manifests itself through the proliferation of aquatic plants and a significant reduction in the oxygen content of the water. The consequences include reduced animal and plant diversity and disrupted uses (Source: OFB).
Good Ecological Status	The WFD default objective for all water bodies, defined as a slight variation from undisturbed conditions. The elements that make up Ecological Status include: biological elements (including fish, macro-invertebrates, macrophytes and diatoms); and supporting elements (made up of hydromorphology, ammonia, pH, phosphates, dissolved oxygen and 18 pollutants including some heavy metals and pesticides). Each of these elements contributes to the overall ecological status. A lowest common denominator rule is applied to the elements, so the lowest scoring element denotes the overall status of the water body. For example, if a biological quality element was at moderate and other quality elements were at good, it would be assumed that the water body as a whole is at moderate status. (Source: ECRR).
Invasive alien species	Species introduced into an area distinct from its area of origin by human beings, deliberately or accidentally, proliferating in its area of establishment

	and disrupting the functioning of ecosystems or harming native species through competition, predation or transmission of disease. (Source: OFB)
IUCN Red List	IUCN Red List A regularly revised list of species classified according to the degree of threat to which they are exposed, based on a methodology defined by the IUCN. (Source: OFB)
Macropollutant	A combination of suspended solids, organic matter and nutrients such as nitrogen and phosphorus. Macropollutants may occur naturally in water, but human activities increase their concentrations (industrial or domestic wastewater discharges, or agricultural practices). (Source: OFB)
Micropollutant	A group of mineral or organic substances which, even at very low concentrations of the order of µg/l or ng/l, can be toxic to humans and/or ecosystems. They are generally classified into families: metalloids, hydrocarbons, PAHs, PCBs, polybrominated diphenyl ethers (PBDEs), volatile organic compounds (VOCs), volatile organohalogen compounds (VOCs), phenolic compounds, dioxins and furans, phthalates, etc. (Source: OFB)
Natural soils	They include woodland, moorland and fallow land, bare soil (coastal dunes, sandy or pebble beaches, etc.) and wetlands (Source: AGRESTE).
Quantitative status of groundwater	Assessment of a body of water, taking into account the level of volumes of water withdrawn in relation to the resource's capacity to renew itself and its capacity to maintain the supply of surface ecosystems (Source: OFB).
Red List Index	Index measuring the risk of extinction of species by noting more or less rapid declines in numbers. It is constructed using the number of species in each IUCN threat category and the number of species that have changed category. (Source: OFB)
River basin	Area delimited by watersheds in which run-off water converges through a network of rivers, streams and possibly lakes towards the sea (Source: OFB).
Soil sealing	Transformation of agricultural, natural or forest land by development actions, which may result in it being totally or partially sealed. (Source: INSEE)
Sealed soil	They include built-up land (dwellings, factories, etc.), paved land (roads, squares, etc.), stabilised land (railways, quarries, building sites, etc.) and other artificial land (gardens, parks and green spaces, etc.). (Source: AGRESTE)
Water body	According to the Water Framework Directive, a body of surface water is a distinct and significant part of surface water (lake, reservoir, river or canal, part of a river or canal, transitional water or part of coastal waters). For watercourses, the delimitation of water bodies is based mainly on the size of the watercourse and the notion of hydro-ecoregion. A groundwater body is a distinct volume of groundwater within one or more aquifers. (Source: OFB)

Abbreviations

AC3A	Association of the Chambers of Agriculture of the Atlantic Area
AEE	European Environment Agency
AESN	Seine-Normandy Water Agency
CE	European Commission

CLE	Local Water Commission
CNRS	National Centre for Scientific Research
DCE	Water Framework Directive
DREAL	Direction régionale de l'environnement, de l'aménagement et du logement (Regional directorate for the environment, planning and housing)
FAO	Food and Agriculture Organization of the United Nations
FREC	Circular economy roadmap
IPCC	Intergovernmental Panel on Climate Change
HCBC	Brittany High Council for Climate
INRAE	French National Research Institute for Agriculture, Food and the Environment
INSEE	French National Institute for Statistics and Economic Studies
GHG	Greenhouse gases
MNHN	National Museum of Natural History
OFB	French Biodiversity Office
ONB	National Biodiversity Observatory
SAGE	Water development and management plan
SAU	Useful Agricultural Area
SDAGE	Master plan for water development and management
SDES	Statistical Data and Studies Department
SNBC	National low-carbon strategy
IUCN	International Union for Conservation of Nature

1 Resource management profiles

1.1 Water resources management profile

Water management in France

In France, the law 2004-338[1] transposed the 2000 EU Water Framework Directive (WFD) into national law, introducing management by major river basins (six in metropolitan France) and setting targets for achieving good water status. Water governance is complex and relies on numerous consultation bodies and technical organisations. Basin committees (one for each river basin) play a central role in drawing up water development and management master plans (SDAGE). These committees bring together representatives of the State, local authorities, and users (industry, farmers, associations, etc.) to decide on the strategy for protecting water and aquatic environments. The SDAGE is drawn up for six years (the current period is 2022-2027), in line with European and national water policies. It defines the guidelines for the balanced and sustainable management of water resources; sets the quality and quantity objectives to be achieved for each water bodies in the basin (rivers, water bodies, groundwater, estuaries, coastal waters), and determines the developments and provisions needed to prevent deterioration and ensure the protection and improvement of the status of water and aquatic environments, to achieve these objectives[2]. The Water Agencies, public bodies, are responsible for implementing this strategy in collaboration with government departments and regional and county councils. These agencies play a central role in water management: they collect fees from users (consumers, economic activities), which they redistribute in the form of loans and subsidies to local authorities and economic and agricultural actors to implement actions: production of high-quality drinking water, water purification, maintenance, and restoration of aquatic environments. Another key mission of the water agencies is to collect, share and disseminate data on the quality of water. Each river basin is divided into sub-basins, where a Local Water Commission (CLE), set up by the Prefect and made up of water managers, farmers, consumer, and industry representatives, is responsible for drawing up, revising, and monitoring the application of the Water Development and Management Scheme (SAGE). Finally, the management of urban water services (drinking water and sanitation), the management of aquatic environments and flood protection are the responsibility of the municipalities or their groupings[3].

Water resources and use

On a national level, the average consumption per person is 146 litres of drinking water a day, representing an average annual cost per household of 500 €. Annual rainfall in France amounts to 500 billion m^3, 60% of which returns to the atmosphere, with the remainder flowing into rivers, lakes, and groundwater. 37 billion m^3 of water (excluding hydroelectricity) is withdrawn for various uses: 51% is used to cool power stations, 18% to produce drinking water, 14% to supply navigation channels, 10% for irrigation, 6% for industry and 1% for other uses (source: OFB[4] 2023). Groundwater is the source of two-thirds of the water distributed to the domestic users.

In the Atlantic Arc, this situation differs at the level of each river basin but will also vary if we consider each administrative region, which may be integrated by several basins, as is the case with New-Aquitaine. The three river basin districts that we look at in this report are Adour-Garonne, Loire-Brittany,

[1] Law no. 2004-338 of 21 April 2004 transposing Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy.
[2] Ministère de la Transition écologique et de la Cohésion des territoires, Ministère de la Transition énergétique, *Gestion de l'eau en France*, Juin 2023. https://www.ecologie.gouv.fr/gestion-leau-en-france
[3] INRAE, Dossier de presse – *Gestion de la ressource en eau*, Juin 2023. https://www.inrae.fr/dossiers/gestion-ressource-eau/gouvernance-leau-previsions
[4] Office français de la biodiversité (OFB), *Prélèvements en eau en France, un suivi nécessaire*, Décembre 2023. https://www.eaufrance.fr/publications/prelevements-en-eau-en-france-un-suivi-necessaire

and Seine-Normandy. The scale of the basin is preferred to that of the administrative region because the data used in this report is the official data reported by the water agencies.

Figure 1 Overlay of the boundaries of the four administrative regions in the French Atlantic Arc against the River Basin Districts they lie in

Map of river basin districts

© OFB[5], 2020

Map of administrative regions

© Ministère de l'Intérieur et des Outre-Mer[6], 2016

French Atlantic Arc

[5] Source: https://www.eaufrance.fr/media/les-bassins-hydrologiques-metropolitains
[6] Source: https://mobile.interieur.gouv.fr/Archives/Archives-des-actualites/2016-Actualites/Les-noms-des-nouvelles-regions-sont-actes

Adour-Garonne river basin district

The Adour-Garonne river basin district is made up of several sub-basins (Adour, Charente, Dordogne, Garonne, Lot, Tarn-Aveyron), the coastline and coastal areas, and groundwater.

Figure 2 The Adour-Garonne River Basin District

© Agence de l'eau Adour-Garonne[7]

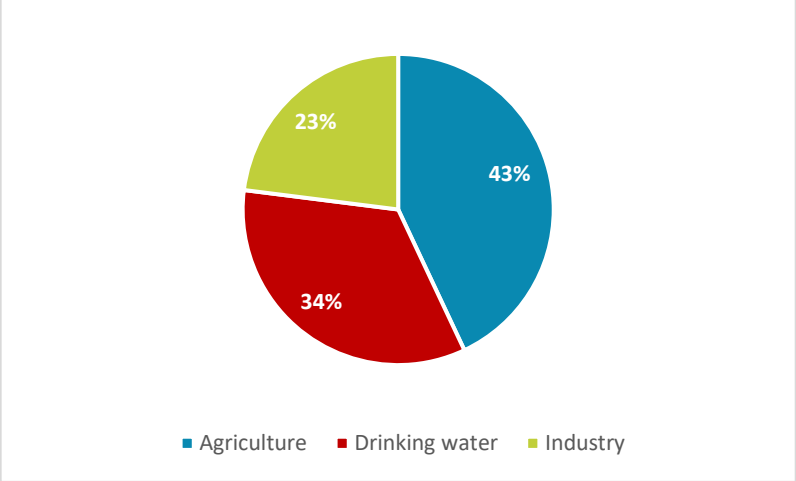
Table 1 Key figures for the Adour-Garonne basin	
Surface area	117,650 km²
River	116,817 km
Coast	630 km
Water bodies	2,952

Source : Water Agency of Adour-Garonne (Agence de l'eau Adour-Garonne)[8].

[7] Source: https://sigesaqi.brgm.fr/-dans-le-bassin-Adour-Garonne-.html
[8] Source: https://eau-grandsudouest.fr/agence-eau/bassins-territoires/bassin-adour-garonne

The Adour-Garonne basin is home to more than 8 million inhabitants and is expected to have 1.5 million more inhabitants by 2050, with consequences for drinking water demand and consumption. Largely rural (50% of the basin's surface area is farmland), agriculture is a major and diversified economic activity (cereal crops, market gardening, mixed farming, livestock farming, wine growing, etc.). This river basin alone accounts for 1/3 of the total number of French farms. Hydroelectricity production amounts to 15,000 GWh (20% of national production), with 1,100 hydroelectric installations and a storage capacity of 2.5 billion m³ of water in large dams[9].

Figure 3 Breakdown of water withdrawal in Adour-Garonne (2 billion m3/year)



Source: Agence de l'eau Adour-Garonne, Septembre 2021[10].

Despite a high average annual rainfall (600 mm in the middle part of the Garonne valley to 2000 mm on the higher ground), water resources are subject to significant seasonal fluctuations and the basin regularly experiences severe low-water periods, resulting from an imbalance between abstractions and available resources[11]. The low flows of the rivers are then compensated for by large artificial reserves: more than 640 million m³. Large hydroelectricity reserves store 2.5 billion m³, of which more than 160 million can be mobilised in the summer to support river flows. Projections of the impact of climate change on water resources are particularly alarming: natural low-water flows would be halved by 2050 in a scenario where the average air temperature will have risen by 2°C compared with today. The satisfaction of all uses and the development of all activities with a potential impact on water resources therefore requires sustainable management in consultation with the various stakeholders.

Key figures and recommendations regarding surface water bodies

More than half of rivers and lakes in the Adour-Garonne river basin district fail to achieve Good Ecological Status. Economic activities and management practices that could have substantial negative impacts on river and lake ecology should thus be avoided, and those that could improve the ecological conditions of these water bodies should be explored and favoured.

[9] Agence de l'eau Adour-Garonne, *Eau et changements climatiques dans le grand Sud-Ouest*, Septembre 2021. https://www.calameo.com/agence-de-leau-adour-garonne/read/000222592d3688961fd70?page=1
[10] *Ibid.*
[11] Agence de l'eau Adour-Garonne, *L'état des ressources, gestion quantitative*, 2020. https://eau-grandsudouest.fr/usages-enjeux-eau/eau-grand-sud-ouest/etat-ressources-gestion-quantitative

According to the data from the second reporting cycle of the WFD[12], about two-thirds of surface water bodies achieve Good Chemical Status, though this figure remains below the EU average. Nitrogen and phytosanitary pressures are significant for more than 35% of surface water bodies, mainly in areas where field crops are concentrated[13]. A significant number of rivers are reported as having an unknown chemical status. Economic activities that keep this situation from improving, or that could further deteriorate the chemical properties of water resources, should be avoided. Bioeconomy activities and management practices that could contribute to improve the chemical status of water bodies in the river basin district should be sought and promoted.

According to the reported data, half of the rivers and one-third of lakes in the river basin district are affected by atmospheric deposition as a diffuse source of pollution. This shows that economic activities that could exacerbate pollution through atmospheric deposition should be avoided in the region.

About half of the rivers in the region are affected by some form of chemical, nutrient, or organic pollution. Activities resulting in discharges of these substances should thus be avoided.

Habitat alterations resulting from changes in morphology are a significantly recurrent impact on lakes and rivers in the region: 38% of water bodies in rivers and lakes suffer from a high degree of morphological alteration[14], particularly in relation to hydroelectric dams and river weirs. Economic activities and management practices that facilitate or promote the restoration of these lakes should be favoured.

Key figures and recommendations regarding groundwater bodies

A significant portion of groundwater bodies in the river basin district are in Good Quantitative Status and a large proportion (two-thirds) are in Good Chemical Status as well. The 28 groundwater bodies are in good chemical condition, but 6 of them are in poor quantitative condition due to the pressure of water withdrawals: the Adour-Garonne basin withdraws 293 million of m^3 of groundwater annually[15], 70% of which for drinking water. These pressures on groundwater resources are likely to increase with the impact of climate change: as it is forecasted that there will be a shortfall of 1.2 billion m^3 between needs and surface water resources[16].

There are around 4,800 water catchments in the Adour-Garonne basin, 80% of which have been protected to prevent occasional or accidental pollution. Of these, 95 water catchments have been identified as priorities for restoring quality because of damage caused by diffuse pollution (nitrates and/or pesticides)[17]. Groundwater bodies in poor chemical conditions are being affected by diffuse sources of pollution and, to a lesser extent, abstraction. Economic activities that could exacerbate these pressures should be avoided. Chemical pollution is the most recurrent impact on groundwater bodies in the river basin district. Economic activities associated to moderate or high discharges of chemicals to the environment should be avoided.

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[12] WISE WFD Data Viewer (https://www.eea.europa.eu/data-and-maps/dashboards/wise-wfd). Data from the 3rd WFD reporting cycle was not yet available on the WISE Database at the time of the analysis.
[13] Agence de l'eau Adour-Garonne, *SDAGE 2022-2027*, Mars 2022. https://eau-grandsudouest.fr/sites/default/files/2022-04/SDAGE%202022-2027%20ADOUR%20GARONNE.pdf
[14] *Ibid.*
[15] Agence de l'eau Adour-Garonne, SDAGE 2022-2027 – Commission territoriale nappes profondes, *Synthèse de l'état des lieux*, Mai 2020. https://www.calameo.com/agence-de-leau-adour-garonne/read/0002225928abd87967b70
[16] Agence de l'eau Adour-Garonne, *Le changement climatique sur le bassin*, 2020. https://eau-grandsudouest.fr/usages-enjeux-eau/changement-climatique/changement-climatique-bassin
[17] Agence de l'eau Adour-Garonne, *La qualité des eaux*, 2020. https://eau-grandsudouest.fr/usages-enjeux-eau/eau-grand-sud-ouest/qualite-eaux

Loire-Brittany river basin district

The Loire-Bretagne basin is made up of the Loire (France's longest river at over 1,000 km) and its tributaries, the coastal basins of Brittany and Vendée, and the Marais Poitevin. The region is characterised by its extensive coastline, large but heavily used groundwater resources and numerous wetlands.

Figure 4 The Loire-Brittany River Basin District

© Agence de l'eau Loire-Bretagne[18]

Table 2 Key figures for the Loire-Bretagne basin	
Surface area	156,000 km²
River	135,000 km
Coast	2,600 km
Water bodies	2,210

[18] Map date: 13 octobre 2017 – Period of the data: October 2017 - © Agence de l'eau Loire-Bretagne. https://agence.eau-loire-bretagne.fr/home/bassin-loire-bretagne/le-territoire-naturel-de-loire-bretagne.html

Source : Water Agency of Loire-Brittany (Agence de l'eau Loire-Bretagne)[19].

The Loire-Brittany basin has significant renewable water resources: annual rainfall ranges from 500 mm to 1,700 mm but is unequally distributed across the region. Drinking water supply comes largely from reservoirs that are filled by winter rainfall, and when winter and spring are very dry, there is considerable pressure on the resource. For example, the summer of 2022 was marked by drought, caused by a severe water deficit during the previous winter (rainfall of between 2 and 25% of normal monthly levels in some counties). Many counties in Brittany and Pays de la Loire were placed on drought alert, with restrictions applied to the use of drinking water.

In similarity to the Adour-Garonne basin, climate forecasts predict a significant drop in river flows between now and 2050 (-40%) and in groundwater recharge (-10 to -30%)[20]. These changes will have an impact on water quality (increased risks of pollution), saline intrusions (associated to reduced water volumes in the aquifers compounded with sea level rise), and an increase in the surface area of mud deposits in estuaries. Drier soils will reduce the capacity to recharge groundwater and increase run-off: the Loire basin will experience more sudden, intense, and widespread flooding, which will also have an impact on the quality of water in rivers.

Key figures and recommendations regarding surface water bodies

Three-quarters of rivers and lakes in the river basin district fail to achieve Good Ecological Status, with regional variations: in the Pays de la Loire region, 86% of surface waters could fail to achieve good ecological status by 2027[21].

This is due to the numerous pressures affecting hydrology (withdrawals), morphology (obstacles to water flow) and pollution (diffuse pollution by transfers of nitrates and pesticides into watercourses, occasional pollution caused by macro-pollutants). As a result, 79% of watercourses (1,492 of the 1,887 existing water bodies) are at risk of failing to meet their environmental objectives by 2027[22].

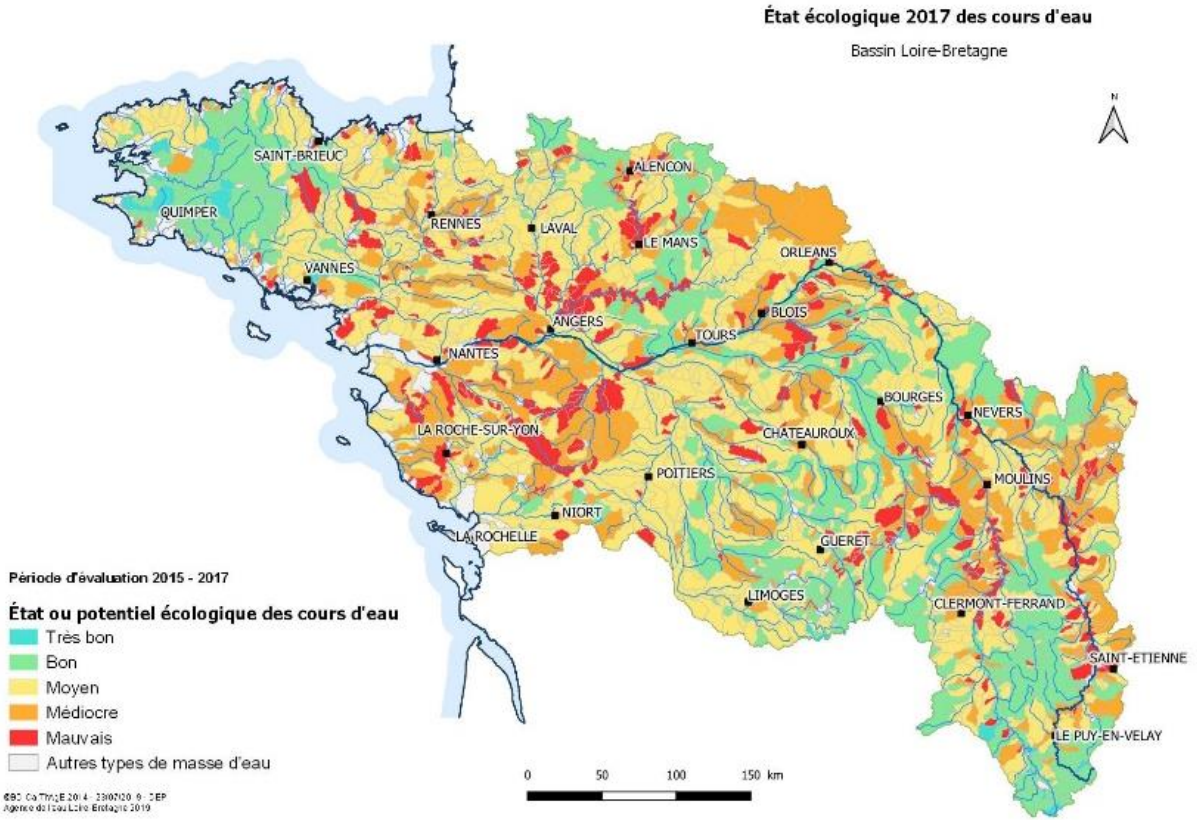
[19] Agence de l'eau Loire-Bretagne, *SDAGE 2022-2027 - Etat des lieux du bassin Loire-Bretagne*, Décembre 2019. https://sdage-sage.eau-loire-bretagne.fr/files/live/mounts/midas/Donnees-et-documents/EDL2019-Erratum.pdf

[20] Agence de l'eau Loire-Bretagne, *Prospective territoriale 2050 à l'échelle du bassin Loire-Bretagne*, Septembre 2023. https://sdage-sage.eau-loire-bretagne.fr/files/live/mounts/midas/Sdage-et-Sage/Prospective_territoriale

[21] GIEC des Pays de la Loire / Comité 21, 1er rapport, Juin 2022. https://www.calameo.com/read/002150178c7aa01db4831?page=1

[22] Agence de l'eau Loire-Bretagne, *SDAGE 2022-2027 - Etat des lieux du bassin Loire-Bretagne*, Décembre 2019. https://sdage-sage.eau-loire-bretagne.fr/files/live/mounts/midas/Donnees-et-documents/EDL2019-Erratum.pdf

Figure 5 Ecological status of rivers in the Loire-Brittany basin in 2017 (Green = Very good ; Red = Bad)



© Agence de l'eau Loire-Bretagne[23]

The map above shows that these pressures apply differently in different locations, depending on land use and territorial practices. Three main factors are involved: soil sealing (the quality of the water around major urban areas such as Nantes, Angers and Le Mans has deteriorated significantly due to the increased runoff among other factors), the adjustment of watercourses and farming practices (abstraction for irrigation, drainage, fertiliser, and plant protection product inputs). For example, in the Pays-de-la-Loire region, withdrawals for drinking water and irrigation increased by 16% between 2012 and 2019[24].

Therefore, economic activities and management practices that could have substantial negative impacts on river and lake ecology should be avoided, and those that could improve the ecological conditions of these water bodies should be explored and favoured.

About one-third of surface water bodies achieve Good Chemical Status, while more than half are reported as unknown. Economic activities that keep this situation from improving, or that could further deteriorate the chemical properties of water resources, should be avoided. Bioeconomy activities and management practices that could contribute to improve the chemical status of water bodies in the river basin district should be sought and promoted.

[23] Agence de l'eau Loire-Bretagne, *Zoom sur la qualité des eaux en Loire-Bretagne*, Juillet 2019. https://agence.eau-loire-bretagne.fr/home/bassin-loire-bretagne/zoom-sur-la-qualite-des-eaux-en-loire-bretagne-2020.html?dossierCurrentElemente45c63ca-4536-4b29-97c5-1cc2713d5974=f3610971-6ff0-4ee5-9cec-2b4e42dcc203

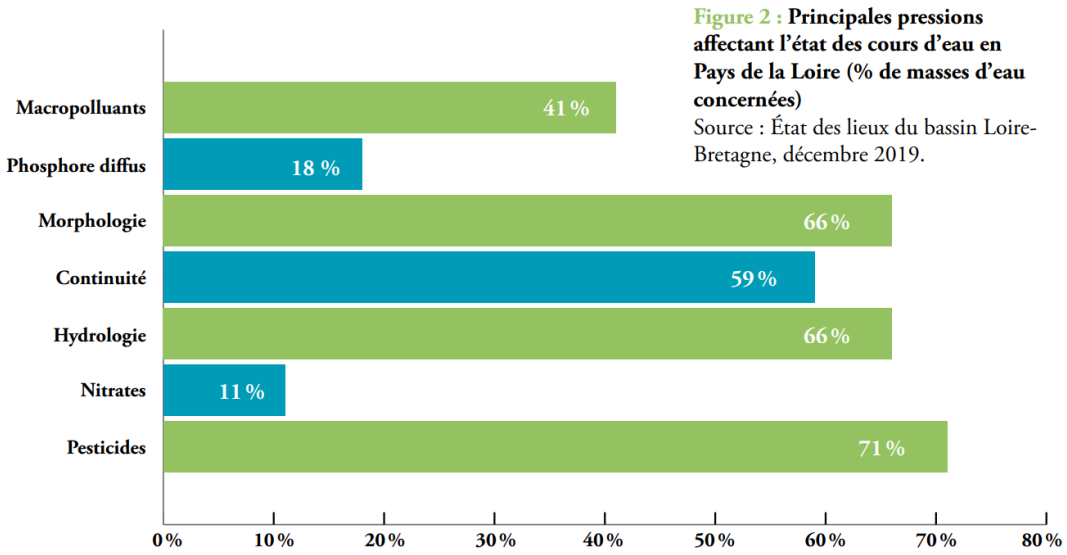
[24] Source des données : Agence de l'eau Loire-Bretagne, *SDAGE 2022-2027 - Etat des lieux du bassin Loire-Bretagne*, Décembre 2019. https://sdage-sage.eau-loire-bretagne.fr/files/live/mounts/midas/Donnees-et-documents/EDL2019-Erratum.pdf

More than half of the rivers in the region face hydromorphological pressures, leading to altered habitats. Economic activities and management practices that facilitate or promote the restoration of these rivers should be favoured.

Pollution (both point source and diffuse) is also an important pressure on about one-third of rivers, which face chemical, nutrient, and organic pollution. Activities that could exacerbate pollution through atmospheric deposition as well as chemical and organic discharges should be avoided in the region.

Furthermore, half of the lakes in the region are affected by atmospheric deposition as a diffuse source of pollution. Again, economic activities that could contribute to atmospheric pollution should be avoided.

Figure 6 Main pressures affecting the status of rivers in Pays de la Loire[25]



Key figures and recommendations regarding groundwater bodies

A significant portion (87%[26]) of groundwater bodies in the river basin district are in Good Quantitative Status and a large proportion (two-thirds) are in Good Chemical Status as well.

Groundwater bodies in poor chemical conditions are being affected by diffuse sources of pollution, mainly from agricultural origin: 42% of water bodies, corresponding to 61 water bodies, are at risk in terms of quality, 23 because of nitrates alone, 12 because of a combination of nitrates and pesticides, and 11 because of pesticides alone[27]. Therefore, economic activities that could exacerbate these pressures should be avoided.

Nutrient pollution is the most recurrent impact on groundwater bodies in the river basin district. Economic activities associated to moderate or high discharges of nutrients to the environment should be avoided.

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[25] Région Pays de la Loire, Agence de l'eau Loire-Bretagne, *Plan Etat-Région pour la reconquête de la ressource en eau en Pays de la Loire*, Décembre 2019. https://www.paysdelaloire.fr/sites/default/files/2020-12/plan-etat-region-pour-la-reconquete-ressource-eau.pdf

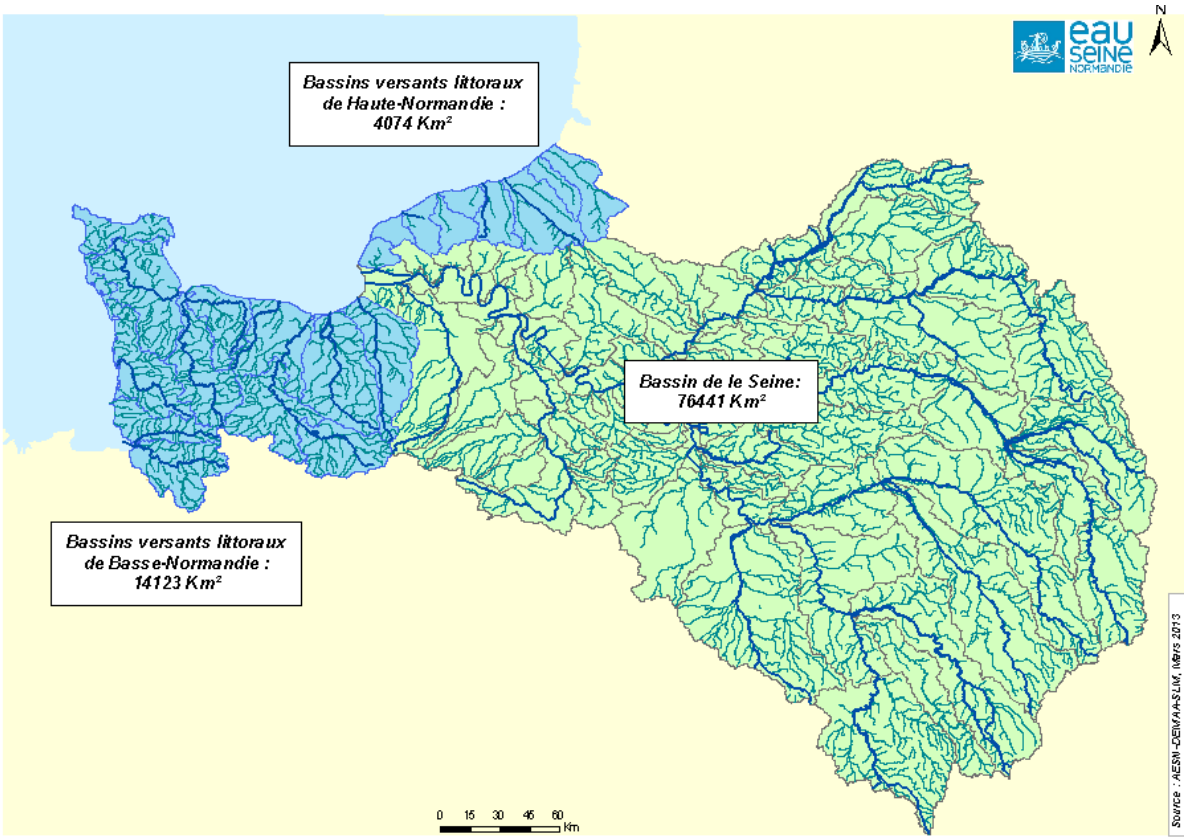
[26] Agence de l'eau Loire-Bretagne, *Zoom sur la qualité des eaux en Loire-Bretagne*, Juillet 2019. https://agence.eau-loire-bretagne.fr/home/bassin-loire-bretagne/zoom-sur-la-qualite-des-eaux-en-loire-bretagne-2020.html?dossierCurrentElemente45c63ca-4536-4b29-97c5-1cc2713d5974=f3610971-6ff0-4ee5-9cec-2b4e42dcc203

[27] Source des données : Agence de l'eau Loire-Bretagne, *SDAGE 2022-2027 - Etat des lieux du bassin Loire-Bretagne*, Décembre 2019. https://sdage-sage.eau-loire-bretagne.fr/files/live/mounts/midas/Donnees-et-documents/EDL2019-Erratum.pdf

Seine-Normandy river basin district

The Seine-Normandy basin is made up of tributaries and sub-tributaries of the Seine, groundwater and the coastal waters of Normandy. Most of the basin is formed by sedimentary soils, and the underground is rich in groundwater, from which half of the drinking water supply is drawn.

Figure 7 The Seine-Normandy River Basin District



© AESN, 2013

Table 3 Key figures for the Seine-Normandy basin	
Surface area	94,500 km²
River	1,651
Coast	650 km
Water bodies	1,782

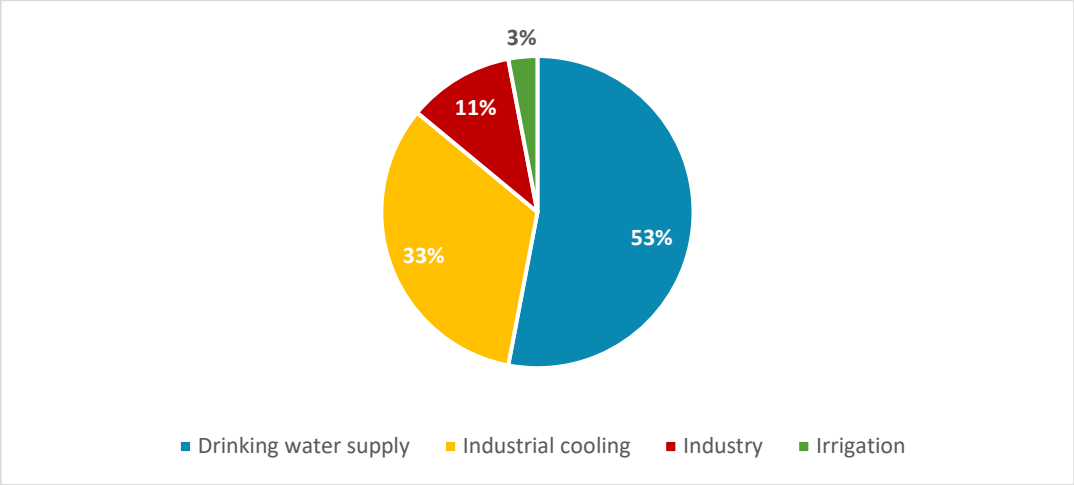
Source : Water Agency of Seine-Normandy (Agence de l'eau Seine-Normandie - AESN)[28].

The basin's extensive water resources are heavily exploited and subject to multiple pressures. Indeed, the basin is characterised by a high level of human activity: it is home to 30% of the national population,

[28] Data source: Agence de l'eau Seine-Normandie. https://www.eau-seine-normandie.fr/agence-de-leau/le-bassin-de-la-seine#:~:text=La%20fa%C3%A7ade%20littorale%20du%20bassin,154%20plages%20et%2019%20ports

40% of industry (petrochemicals, specialised chemicals, car manufacturing, aeronautics, mechanical engineering, etc.) and 25% of agriculture (cereals, sugar beet, cattle, etc.), on 18% of the national surface area. Water abstraction (3 billion m^3 per year) puts pressure on groundwater levels and river flows and can affect the functioning of aquatic life and wetlands. In addition, the low relief of the basin makes it highly affected by river modifications, and the main estuaries are the site of large-scale port facilities. Run-off is very slow and subject to very high levels of evaporation: of the 820 mm of average annual rainfall, only 30% is run-off[29].

Figure 8 Distribution of water withdrawals in the Seine-Normandy basin



Source : AESN, SDAGE Seine-Normandie, 2019[30]

Key figures and recommendations regarding surface water bodies

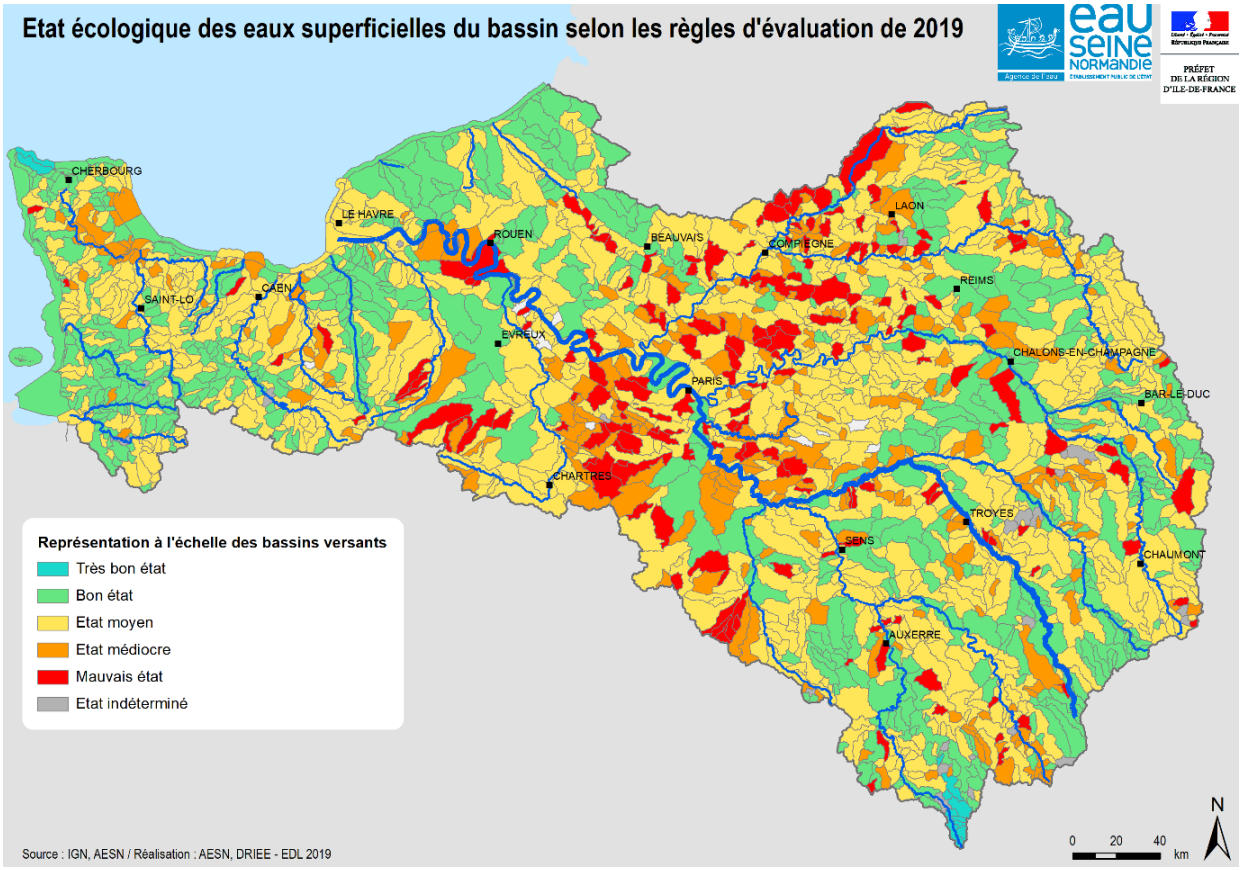
More than half the region's rivers and most of the lakes are not achieving Good Ecological Status. Out of 47 lakes, only 4 achieve Good Ecological Status[31]. Thus, the scale and placement of any economic activities that could have substantial negative impacts on river and lake ecology should be planned very carefully to ensure that progress attained so far in meeting regulatory targets is not lost and instead continues to expand.

[29] Data source: Agence de l'eau Seine-Normandie, *Etat des lieux 2019 du bassin de la Seine et des cours d'eaux côtiers normands*, Janvier 2020. https://www.eau-seine-normandie.fr/sites/public_file/inline-files/AESN_Classeur.pdf

[30] Agence de l'eau Seine-Normandie, *Etat des lieux 2019*, Janvier 2020. https://www.eau-seine-normandie.fr/sites/public_file/inline-files/AESN_etat_lieux_janvier20.pdf

[31] *Ibid.*

Figure 9 Ecological status of rivers in the Seine-Normandy basin according to 2019 assessment rules (Green = Very good; Red = Bad)[32]



© AESN, 2019[33]

Two-thirds of surface water bodies fail to achieve Good Chemical Status. Economic activities that keep this situation from improving, or that could further deteriorate the chemical properties of water resources, should be avoided. Bioeconomy activities and management practices that could contribute to improve the chemical status of water bodies in the river basin district should be sought and promoted.

Almost half of the rivers in the river basin district are affected by either point source or diffuse pollution, most frequently chemical, but also nutrient and organic pollution (in particular nitrogen, phosphorus and organic matter pollution from wastewater treatment plants): the nitrogen flows reaching the Baie de Seine cause disturbances that have a serious impact on algal stranding and episodic developments of toxic microalgae, impacts that are likely to be intensified in the future by climate change[34]. Economic activities associated to moderate or high discharges of chemical pollutants as well as nutrients to the environment should be avoided.

About three-quarters of lakes in the region are affected by nutrient pollution. Economic activities that could exacerbate this should be avoided in favour of those that ameliorate the situation.

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[32] In 2019, new rules for assessing the ecological status of water have been introduced, taking into account scientific progress.

[33] Agence de l'eau Seine-Normandie, *La qualité des rivières du bassin de la Seine et des cours d'eau côtiers normands*, 2020. https://www.calameo.com/agence-de-l-eau-seine-normandie/read/004001913075e8c4b728e

[34] Agence de l'eau Seine-Normandie, *Etat des lieux 2019 du bassin de la Seine et des cours d'eaux côtiers normands*, 2019. https://www.eau-seine-normandie.fr/sites/public_file/inline-files/AESN_Classeur.pdf

Hydromorphology is the most recurrent pressure on rivers in the region: it affects 61% of watercourses. The Seine basin is very much affected by the physical modifications to its rivers and estuaries (dams, port facilities, artificial riverbanks, etc.), with major impacts on wildlife (loss of nursery and breeding areas for aquatic species, obstacles for migratory species, etc.), and on the accumulation of sediments, leading to greater risks of flooding[35]. Economic activities that could associate or contribute to the restoration of these water bodies should be explored and favoured, while those that would entail alterations of the hydromorphology of yet unaffected water bodies should be avoided.

Key figures and recommendations regarding groundwater bodies

There are 57 groundwater bodies in the district, most of them being in Good Quantitative Status (4 are in Poor Quantitative Status: linked to withdrawals for drinking water, for which groundwater supplies 48% of the volume, and the low recharge capacity of the 4 water bodies considered). However, only 30% of these are in Good Chemical Status. Almost all groundwater bodies are affected by diffuse pollution, both chemical and nutrient pollution (leading to eutrophication). Pesticides degrade 61% of groundwater, and diffuse sources of pollution are ubiquitous (linked to the soil sealing and the direct discharge of rainwater, which carries many substances, into watercourses)[36]. Since 2000, 468 drinking water catchments have been closed because of agricultural pollution (nitrates and/or pesticides). It is important that any expansion of existing economic activities, and/or development of new ones, is planned thoroughly and located smartly to avoid the exacerbation of these pressures on currently affected aquifers as well as the affectation of others.

The projections of the basin's Water Agency (AESN) of the pressure factors affecting the river basin warn of an increase in these pressures by 2027, and the risk that the status of aquatic environments and groundwater will deteriorate in the absence of further action to restore and maintain water quality. The AESN estimates that only 18% of watercourses will achieve Good Ecological Status in 2027, compared with the 32% it had forecasted in 2019[37].

[35] Agence de l'eau Seine-Normandie, *Etat des lieux 2019 du bassin de la Seine et des cours d'eaux côtiers normands*, 2019.
https://www.eau-seine-normandie.fr/sites/public_file/inline-files/AESN_Classeur.pdf.
[36] *Ibid.*
[37] *Ibid.*

Conclusions on water resources in the French Atlantic Arc regarding the development of bioeconomy activities

One of the major impacts of climate change will be on the availability (and quality) of water resources. In France, temperatures have already risen and there have been droughts for several years: in 2019, 90 counties saw their rivers dry up. That same year, two-thirds of the country was affected by water restriction measures (source: SDES[38] 2020). The issue of water will therefore have a major impact on the long-term viability of any economic activity and must be considered in the choice of bioeconomy value chains to be developed in the coming years.

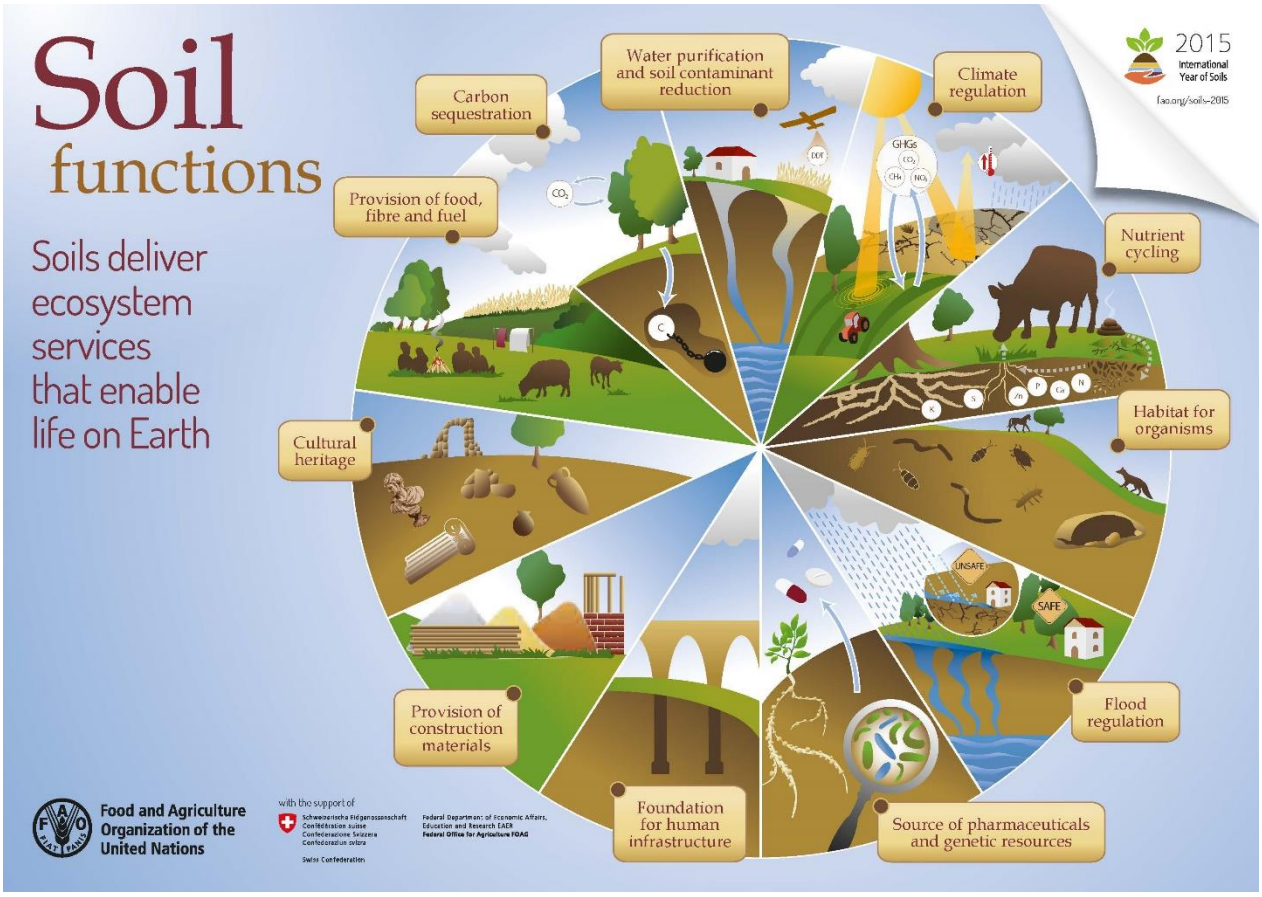
As part of the SCALE-UP project, AC3A and the Chambers of Agriculture of the Atlantic Area are working on the development of fibre crops, particularly for use in biobased building. Some of these crops, notably hemp and miscanthus, are of great interest in restoring and preserving water and soil quality, thanks to the ecosystem services they provide. These ecological benefits are detailed in the deliverable "*T2.3 Regional Biomass and Nutrient Availabilities - Study on the availability of biomass for biobased building in the French Atlantic Arc*", which completes this report.

[38] Service des données et études statistiques (SDES) en partenariat avec l'Office français de la biodiversité (OFB), *Eau et milieux aquatiques – Les chiffres clés*, 2020. https://www.statistiques.developpement-durable.gouv.fr/sites/default/files/2021-02/datalab_80_chiffres_cles_eau_edition_2020_decembre2020v2.pdf

1.2 Soil resources management profile

As with water resources, soils are essential to the proper balance of ecosystems and provide numerous services to human activity: agriculture, extraction of raw materials (sand and gravel, slate, sandstone, granite, etc.), housing and infrastructure, etc. As a result, soils are subject to numerous pressures, and their degradation has consequences such as the removal of carbon from the soil and its release into the atmosphere, the degradation of water quality and the disruption of the water cycle, and the loss of biodiversity.... Restoring and preserving them is therefore a key concern today.

Figure 10 Soil functions and ecosystem services



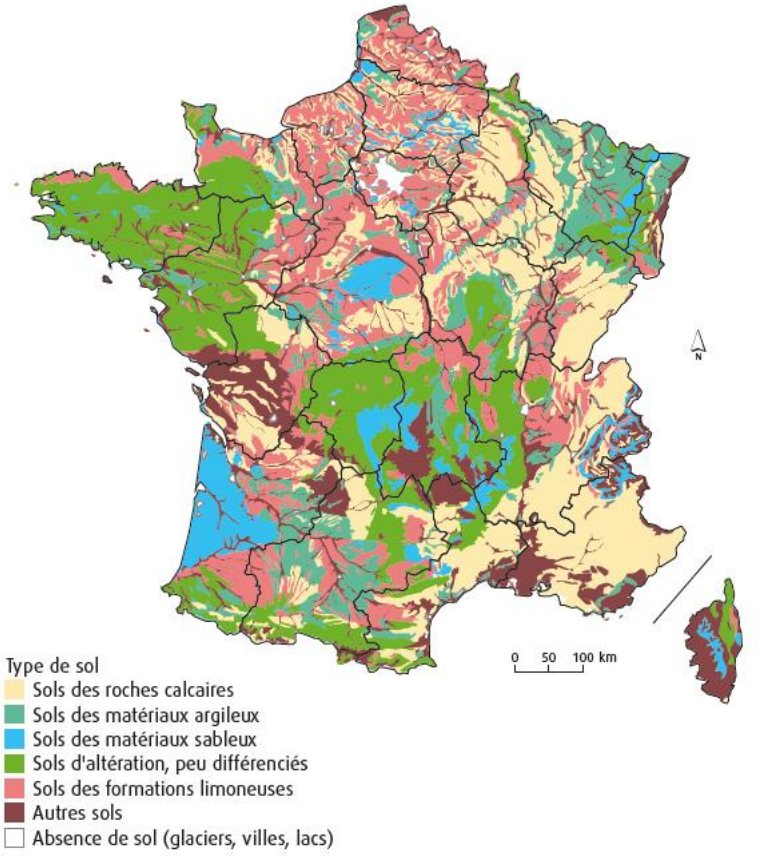
© FAO[39]

Land use in France and its challenges

France has a wide variety of soil types. The map below shows the dominant soils: the Atlantic coast has mainly weathering soils (green), sandy (blue) and calcareous (yellow) materials, as well as silty soils (pink). These different soil qualities will influence their properties and the ecosystem services they provide (for agriculture, carbon sequestration, etc.), as well as their sensitivity to the pressures they face. For example, the sandy soils of the Nouvelle-Aquitaine region are highly permeable, so they are poor at sequestering pollutants and protecting water resources. The silty soils of Normandy are more vulnerable to erosion.

[39] Source: https://www.fao.org/3/ax374e/ax374e.pdf

Figure 11 Breakdown of major soil types in mainland France[40]



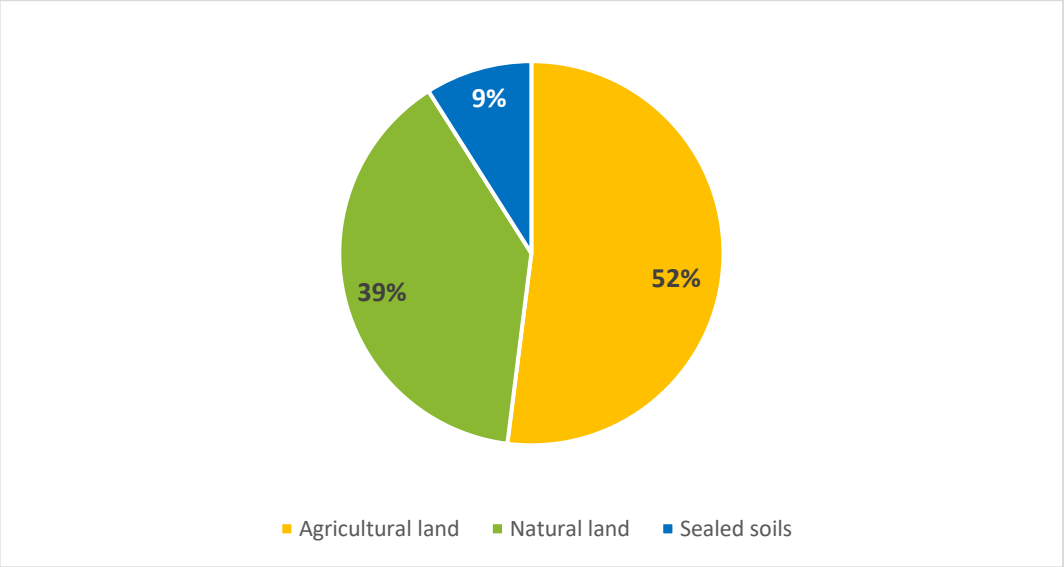
© INRAE[41]

There are three main types of land use: natural land (forests, beaches, wetlands, etc.), agricultural land (cultivated land, meadows used for livestock farming) and sealed soils (facilities, housing…).

[40] Ministère de l'écologie, du développement durable et de l'énergie, *Sols et environnement, Chiffres clefs*, 2015. https://www.statistiques.developpement-durable.gouv.fr/sites/default/files/2019-01/reperes-chiffres-cles-sols-et-environnement-edition-2015-novembre2016.pdf

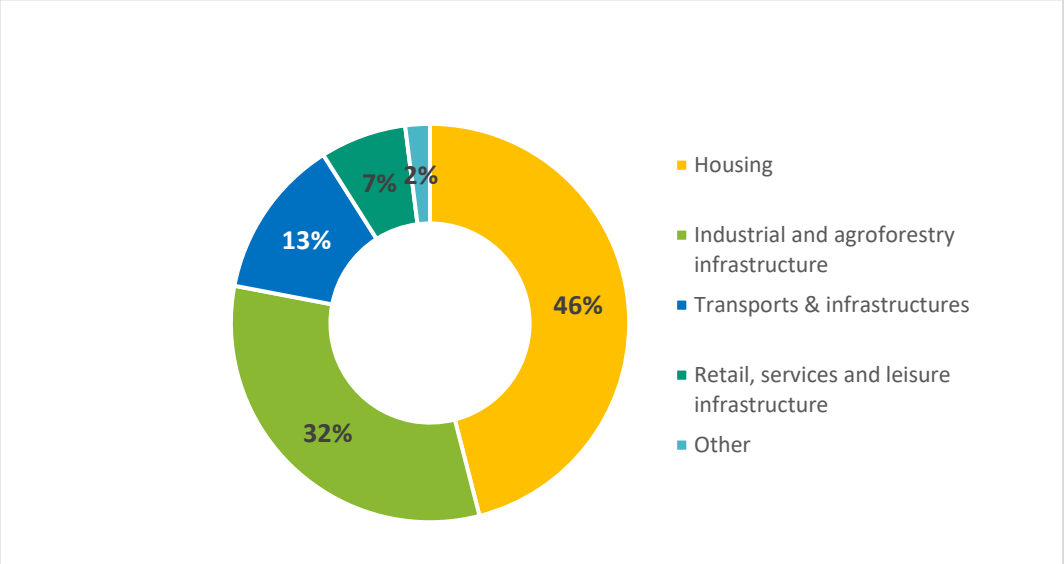
[41] Source : https://www.gissol.fr/donnees/cartes/les-sols-dominants-de-france-metropolitaine-1491

Figure 12 Distribution of physical land cover in mainland France (average 2018-2019-2020) Source: Agreste, 2022



It is estimated that 9% of land is sealed, and this figure is rising steadily. Nearly 45% of sealed soils are impermeable.

Figure 13 Breakdown of sealed land by use (Source: Agreste, 2022)



Nearly irreversible, this sealing amplifies water run-off to the detriment of infiltration, thus increasing the transfer of contaminant-loaded sediments from the soil to watercourses. Sealing soils contributes to soil erosion, increases the risk of flooding, and affects biodiversity by fragmenting natural habitats and irreparably transforming ecosystems and landscapes[42].

Another major factor in soil loss is erosion, which occurs when the upper layers of a soil are carried away. The main processes involved are physical erosion, responsible for the detachment, transport and sedimentation of soil particles under the action of water (hydric erosion), tillage (arterial erosion) and wind (wind erosion)[43]. This natural and in most cases permanent phenomenon can be caused or amplified by human activity and land use, mainly agriculture and forestry: poor management of agricultural and forestry plots can lead to run-off and significant erosion. Erosion processes affect the

[42] INSEE, 2021. https://www.insee.fr/fr/metadonnees/definition/c2190
[43] Ministère de l'Agriculture et de l'Alimentation, *L'érosion des sols et ses impacts*, Décembre 2021. https://agriculture.gouv.fr/prevenir-lerosion-des-sols-pour-proteger-leurs-ressources-et-leur-biodiversite

soil's ability to perform its functions, and in particular its biomass production and carbon sequestration functions: the chemical fertility of the soil is essentially linked to the properties of the first few centimetres of soil, where the quantity of roots, organisms, living matter and dead organic matter is greatest[44]. The erosion of 15 cm of surface soil affects its fertility in the very long term, even irreversibly. Soil erosion also leads to a reduction in water resources, caused by reduced infiltration and water retention capacity of the soil, as well as a deterioration of water quality (eroded materials carrying pollutants from human activities). Erosion is particularly harmful because it attacks the most fertile soil layers, and as the formation of the soil (pedogenesis) is very slow, it is therefore a real threat to the sustainability of food production worldwide. An FAO[45] report indicates that without action to limit erosion, crop yield projections to 2050 would result in the loss of 1.5 million km² of cultivated land, the equivalent of about all of India's arable land. At national level, agricultural biomass is the second largest material extracted from the soil in terms of volume (232 million tonnes in 2019[46]), and it is estimated that soil losses due to water erosion average 1.5 t/ha/year. **Soil loss of more than 1 t/ha/year can be considered irreversible over a period of 50 to 100 years.**

Coastal erosion, corresponding to the retreat of the coastline and the lowering of beaches, is also a major issue for the regions along the Atlantic Arc, and will be accentuated by climate change, particularly the rise of sea levels.

Lastly, soil salinisation, which corresponds to an increased mineral content in the soils (sodium, potassium, magnesium, calcium, chlorine, sulphate and bicarbonate), is often caused in an agricultural context by the inappropriate irrigation of crops, and also due to massive fertiliser applications (i.e. greenhouse soils). This salinisation adversely affects certain soil organisms, as well as plant growth, making it difficult for plants to extract water. It can make soils unproductive and contaminate water, as it increases toxicity and contributes to the deterioration of soil structure. In France, it is mainly coastal areas that are at risk and could be even more so as sea levels rise, but climate change could also cause soil salinisation to increase across the country as temperatures rise.

Agroecology is one of the solutions studied today to combat soil erosion in agricultural land. Agroecology offers solutions for reducing the use of inputs and tillage while ensuring agricultural production. These solutions include biocontrol (pest control using natural predators), crop diversification, hedgerow management and winter cover.

Governance and soil conservation in France

A new European directive is in progress which results from the EU's Soil Strategy adopted in 2021, in the framework of the European Green Deal. It will step up efforts to enhance soil management, protect soil fertility, reduce erosion and sealing, increase organic matter, increase soil carbon in agricultural land and restore degraded soils, so that by 2050 all soil ecosystems are healthy.

In France, there is no policy dedicated to soil and the issue of soil is therefore addressed in several policies, but in a fragmented way. Soil is governed by the Rural Code, the Environment Code and the Town Planning Code, making public action highly complex. This situation is largely explained by the fact that land is subject to ownership, which makes it more difficult to implement protection measures, and raises problems of acceptability and conflicts of use when introducing new regulations[47]. The main policies relating to soil protection are listed in the table below:

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[44] *Ibid.*

[45] FAO, *Sol erosion, the greatest challenge for sustainable soil management*, 2019. https://www.fao.org/3/ca4395en/ca4395en.pdf

[46] Ministère de la transition écologique et de la cohésion des territoires, *Les sols en France – Synthèse des connaissances en 2021*, Mars 2022. https://www.statistiques.developpement-durable.gouv.fr/les-sols-en-france-synthese-des-connaissances-en-2021#:~:text=%C3%80%20l%27%C3%A9chelle%20mondiale%2C%20le,30%20premiers%20centim%C3%A8tres%20du%20sol

[47] INRAE, *Les sols, un objet politique complexe*, Juin 2023. https://www.inrae.fr/dossiers/peut-encore-sauver-sols/sols-objet-politique-complexe

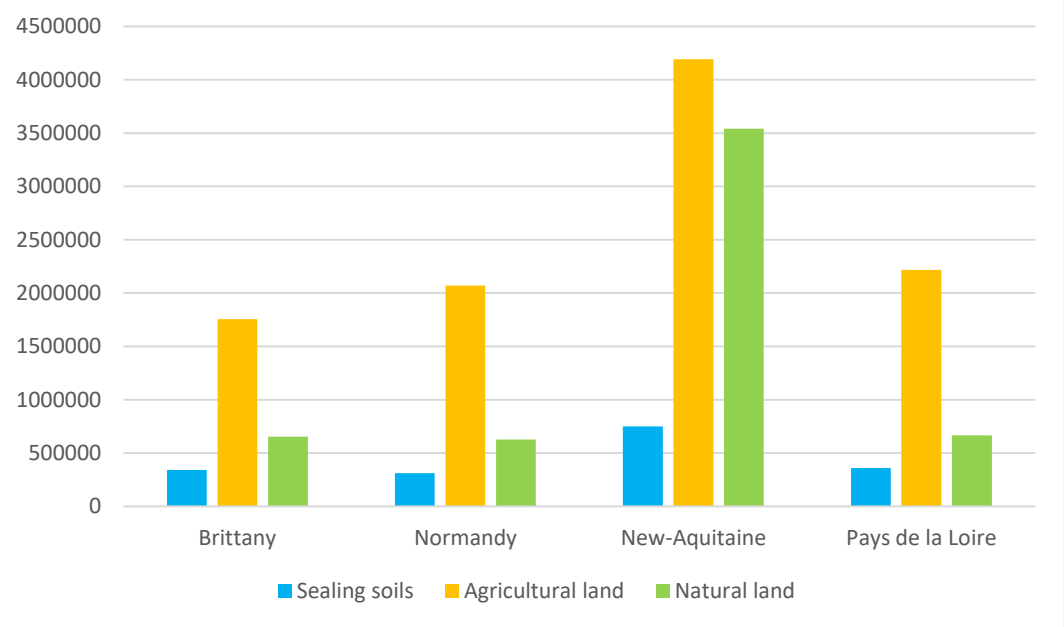
Table 4 Main soil protection policies in France	
National low-carbon strategy – SNBC (2015)	As a roadmap for combating climate change, the SNBC promotes increasing natural carbon sinks to absorb greenhouse gas (GHG) emissions, through the development of agro-ecology, agro-forestry and changes in practices favourable to soil protection (in particular permanent grasslands).
Biodiversity plan (2018)	Introduces the objective of "*Zéro artificialisation nette - ZAN*" (zero land take) by 2050 by limiting the consumption of new areas and recreating natural areas. The Biodiversity Plan was followed by the "National Biodiversity Strategy 2030" adopted in 2023, which sets out 40 measures to reduce the pressures on biodiversity. Measure 26 concerns soil protection and restoration, by improving knowledge and data on soil health and developing funding for soil restoration.
National circular economy roadmap (2018)	The agricultural section of the National circular economy roadmap includes measures to improve soil quality and reduce dependence on fertilisers derived from non-renewable resources.
Sustainable bioeconomy strategy	Adopted by the ADEME (national agency for ecological transition), it is structured around three areas: sustainable management of soil, farming and forestry systems, the development of sustainable food systems, and support for sustainable bio-based industries.

In 2001, France also set up a soil scientific interest group (GIS Sol) to monitor soil quality.

Summary of soil conditions by region in the Atlantic Arc

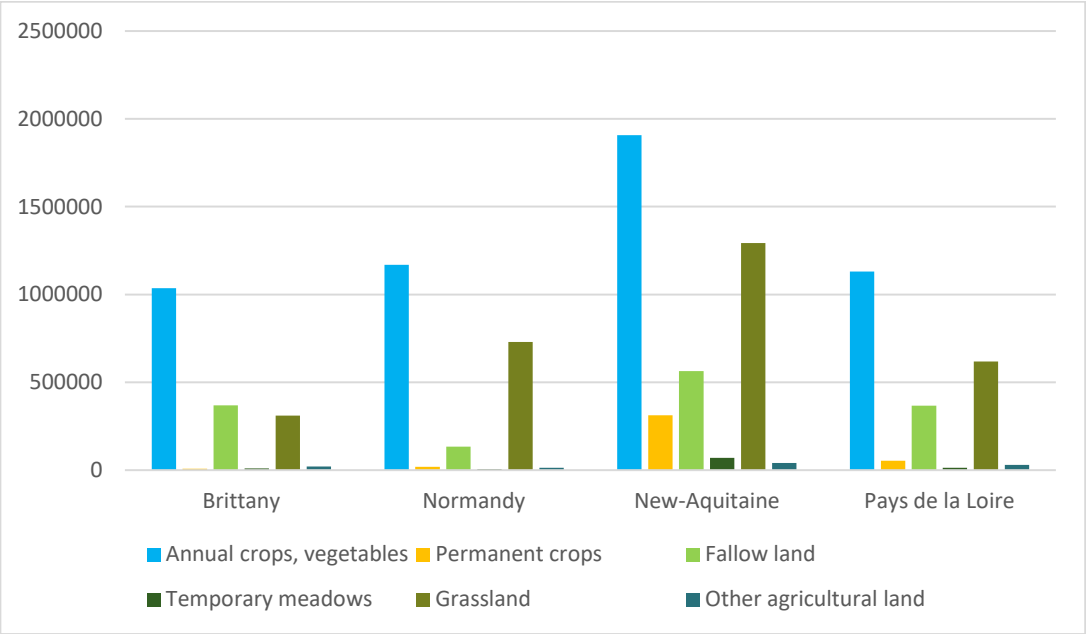
The Atlantic Arc region is exposed to the risk of erosion: coastal erosion, linked to its extensive seafront, but also arable erosion linked to the dominant agricultural use of the land and the intensive practices associated with arable and livestock farming.

Figure 14 Distribution of physical land use in the French Atlantic Arc (in hectares)[48]



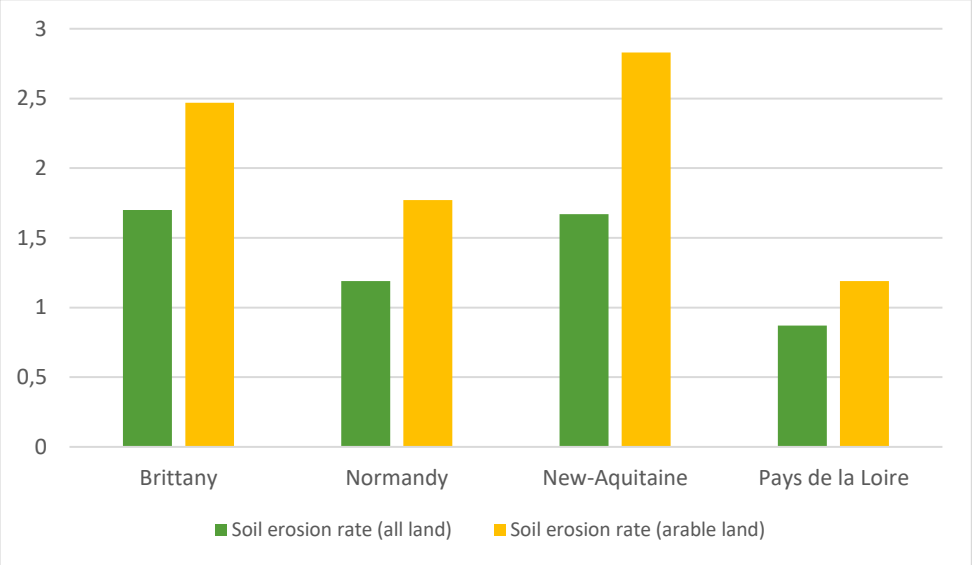
[48] Agreste, *L'utilisation du territoire en 2019 – Enquêtes Teruti 2018-2019-2020*, 2022. https://agreste.agriculture.gouv.fr/agreste-web/download/publication/publie/Chd2212/cd2022-12_teruti_2019.pdf

Figure 15 Distribution of agricultural land in the French Atlantic Arc (in hectares)[49]



The graph below shows a greater erosion of arable land, bearing in mind that the agricultural area for each region represents the largest share of land use (see previous graphs).

Figure 16 Soil erosion rate in the Atlantic Arc regions



Source: RUSLE dataset, 2015[50]

The soil erosion rates for each region remain below the European thresholds for vulnerability to erosion (severe erosion corresponding to a loss of 11 tonnes/hectare/year), but the situation varies at local level and according to the pressures affecting the soil. Therefore, in areas where soil erosion crosses this threshold, or where erosion rates are increasing, some measures can be taken: creating incentives

[49] *Ibid.*
[50] https://esdac.jrc.ec.europa.eu/content/soil-erosion-water-rusle2015

against planting crops on high slopes; creating incentives for erosion control practices such as contouring, conservation tillage or mulching. Specific alternative tillage and mulching practices will depend on the crops being planted, and can often increase yields and reduce costs, however they can lead to an increase in pesticide consumption.

Given the ecosystem services provided by soils (for water quality, biodiversity, etc.), any economic activity that promotes soil restoration and preservation should be encouraged. Ecosystem services are defined as the socio-economic benefits derived by humans from the sustainable use of the ecological functions of ecosystems. When applied to soils, the concept of ecosystem services highlights their capacity to provide, within ecosystems, a wide range of ecological functions that are essential for both humans and the environment.

1.3 Biodiversity management profile

Rich but threatened biodiversity in mainland France

"Biodiversity is the wealth of species and ecosystems, their genetic diversity and their interactions. Beyond their intrinsic value, these species and ecosystems provide an immeasurable number of services to our societies. For example, insects pollinate our fields, wetlands provide us with drinking water and limit the damage caused by flooding, trees protect us from the heat of the city and from erosion in the mountains, the oceans regulate the global climate, and mangroves and dunes protect us from storms. They are the fruit of 4.7 billion years of innovation"[51].

In the era of the Anthropocene, biodiversity is being eroded to such an extent that scientists are talking about a sixth mass extinction of species. At the current rate of deforestation, tropical forests could disappear within 50 to 70 years. Mainland France is not spared by this phenomenon, and the Red List Index of the International Union for Conservation of Nature (IUCN, the international body responsible for monitoring biodiversity worldwide) reports "worrying developments"[52]: 17% of flora and fauna species are now threatened or extinct in France, and their risk of extinction has increased by almost 14% in less than ten years[53]. The French Office for Biodiversity (OFB), a public body dedicated to protecting and restoring biodiversity, estimates that 14% of mammals, 24% of reptiles, 23% of amphibians and 32% of breeding birds are threatened with extinction in mainland France.

There are currently five main categories of pressure on biodiversity[54]:

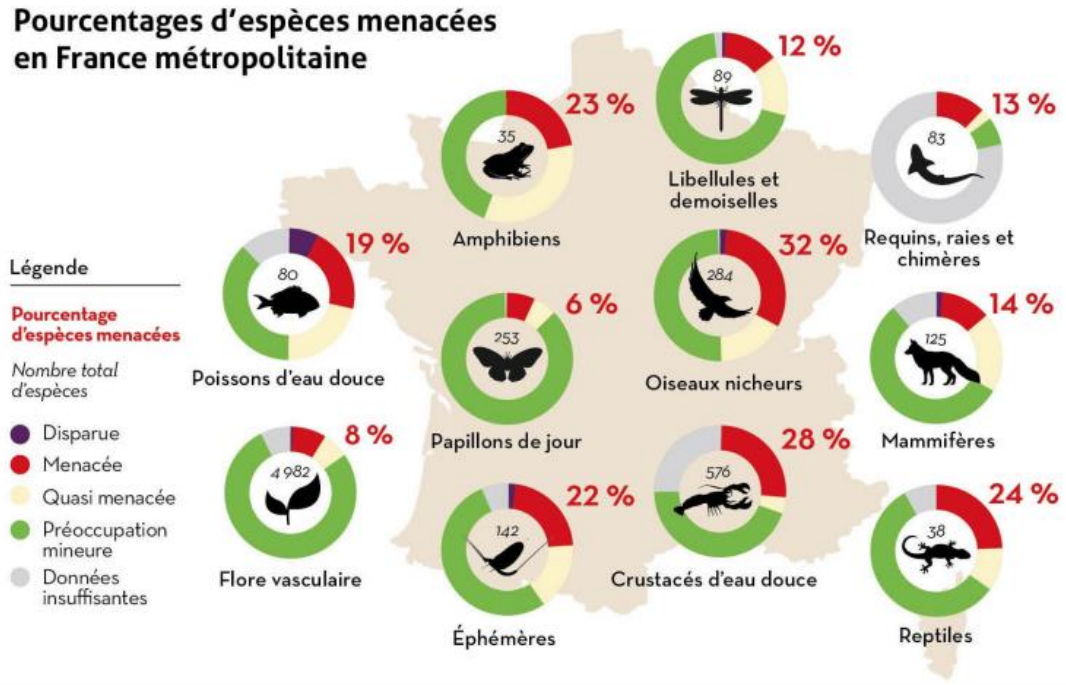
1) **The destruction of natural habitats and soil sealing**. In France, this mainly takes the form of the consumption of natural areas for land development or the intensive use of certain agricultural and forestry areas. The simplification of landscapes and the reduction in the area of grassland also explain the loss of biodiversity in agricultural areas.
2) **Over-exploitation of natural resources and illegal trafficking**. This is the excessive removal of resources from the natural environment (overfishing, deforestation, etc.).
3) **Global climate change**. Rising temperatures (an increase of 1°C in France corresponds to a shift in climatic zones of around 200 km to the north) are leading to changes in the way species live and/or their ranges. It is also leading to an intensification of extreme weather phenomena, particularly droughts, with an impact on flora and fauna.
4) **Pollution of the oceans, freshwater, soil and air**. Dangerous substances, macro-waste, micro-plastics, noise and light pollution... these pollutants are numerous and omnipresent. In France, sales of plant protection products for agricultural use rose by 14% between 2009-2011 and 2018-2020[55]. At the same time, populations of birds specialising in agricultural environments have collapsed by 36% between 1989 and 2021. Generally speaking, the decline

[51] Ministère de la transition écologique et solidaire, *Plan biodiversité*, Juillet 2018. https://www.ecologie.gouv.fr/sites/default/files/18xxx_Plan-biodiversite-04072018_28pages_FromPdf_date_web_PaP.pdf
[52] Ministère de la transition écologique et solidaire, *L'environnement en France – Rapport de synthèse*, 2019. https://www.notre-environnement.gouv.fr/IMG/pdf/9782111570573_lenvironnementenfrance_edition2019_rapportdesynthese_v24_web_light.pdf
[53] Office Français de la Biodiversité, *La biodiversité française en déclin, 10 ans de chiffres-clés par l'Observatoire national de la biodiversité*, 2023. https://www.calameo.com/ofbiodiversite/read/0035029487d2ed5b45958
[54] Ministère de la transition écologique et solidaire, *Les 5 pressions responsables de l'effondrement de la biodiversité*, 2022. https://biodiversite.gouv.fr/les-5-pressions-responsables-de-leffondrement-de-la-biodiversite
[55] Office Français de la Biodiversité, *La biodiversité française en déclin, 10 ans de chiffres-clés par l'Observatoire national de la biodiversité*, 2023. https://www.calameo.com/ofbiodiversite/read/0035029487d2ed5b45958

in specialist, common or rare species (both fauna and flora) is leading to a homogenisation of biodiversity, which is one of the forms of biodiversity decline.

5) **The introduction of invasive exotic species**. Some of the most common in mainland France are the coypu, the Asian hornet, primrose, etc. These species, introduced deliberately or accidentally, disrupt ecosystems and compete with endemic species. In mainland France, there are 84 invasive alien species, with an average of six new species arriving in each county every ten years since 1979[56].

Figure 17 Percentage of threatened species in mainland France (purple = disappeared ; red = endangered ; yellow = almost endangered ; green = low concern ; grey = missing data)

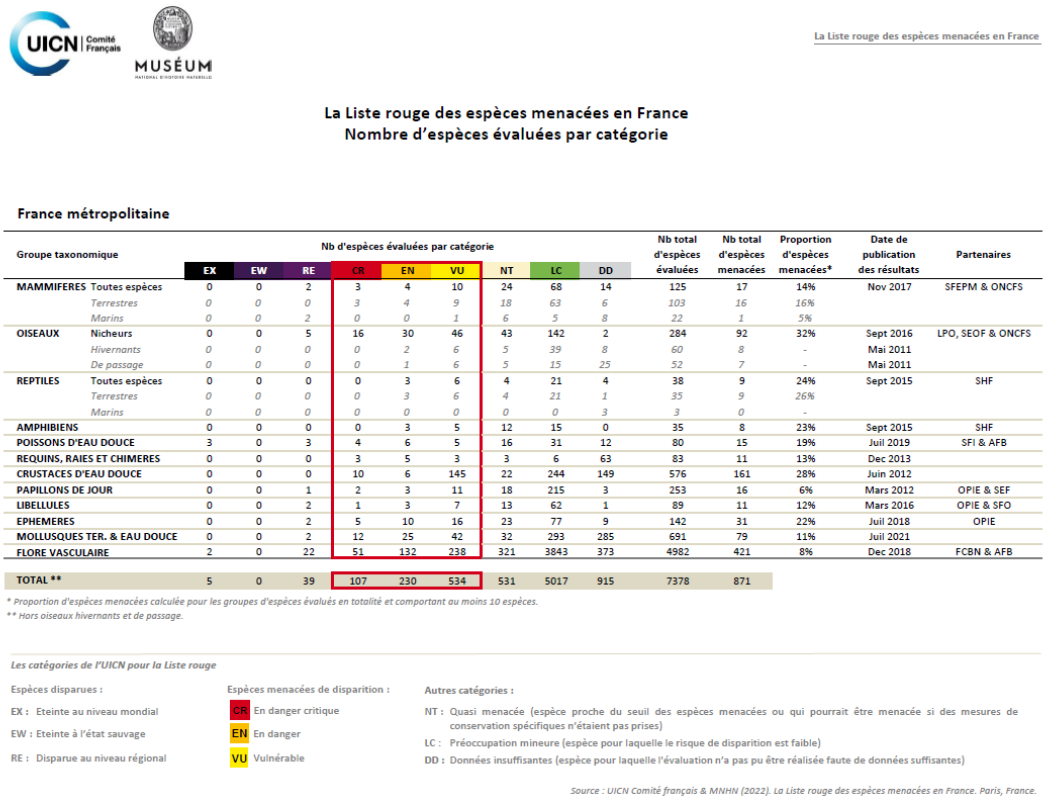


IUCN, 2020[57]

[56] Commissariat général au Développement durable, *La biodiversité sous pression*, Janvier 2020. https://www.vie-publique.fr/parole-dexpert/272596-quel-est-letat-de-la-biodiversite-en-france-les-principales-menaces#:~:text=En%20France%20m%C3%A9tropolitaine%2C%20sur%20un,vivent%20de%20nombreuses%20esp%C3%A8ces%20end%C3%A9miques.

[57] UICN, *La Liste rouge des espèces menacées en France, 13 ans de résultats*, 2020. https://uicn.fr/wp-content/uploads/2021/03/bilan-13-ans-liste-rouge-nationale.pdf

Figure 18 The Red List of threatened species in France



La Liste rouge des espèces menacées en France

La Liste rouge des espèces menacées en France
Nombre d'espèces évaluées par catégorie

France métropolitaine

Groupe taxonomique		Nb d'espèces évaluées par catégorie									Nb total d'espèces évaluées	Nb total d'espèces menacées	Proportion d'espèces menacées*	Date de publication des résultats	Partenaires
		EX	EW	RE	CR	EN	VU	NT	LC	DD					
MAMMIFERES	Toutes espèces	0	0	2	3	4	10	24	68	14	125	17	14%	Nov 2017	SFEPM & ONCFS
	Terrestres	*0*	*0*	*0*	*3*	*4*	*9*	*18*	*63*	*6*	*103*	*16*	*16%*		
	Marins	*0*	*0*	*2*	*0*	*0*	*1*	*6*	*5*	*8*	*22*	*1*	*5%*		
OISEAUX	Nicheurs	0	0	5	16	30	46	43	142	2	284	92	32%	Sept 2016	LPO, SEOF & ONCFS
	Hivernants	*0*	*0*	*0*	*0*	*2*	*6*	*5*	*39*	*8*	*60*	*8*	-	Mai 2011	
	De passage	*0*	*0*	*0*	*0*	*1*	*6*	*5*	*15*	*25*	*52*	*7*	-	Mai 2011	
REPTILES	Toutes espèces	0	0	0	0	3	6	4	21	4	38	9	24%	Sept 2015	SHF
	Terrestres	*0*	*0*	*0*	*0*	*3*	*6*	*4*	*21*	*1*	*35*	*9*	*26%*		
	Marins	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*3*	*3*	*0*	-		
AMPHIBIENS		0	0	0	0	3	5	12	15	0	35	8	23%	Sept 2015	SHF
POISSONS D'EAU DOUCE		3	0	3	4	6	5	16	31	12	80	15	19%	Juil 2019	SFI & AFB
REQUINS, RAIES ET CHIMERES		0	0	0	3	5	3	3	6	63	83	11	13%	Dec 2013	
CRUSTACES D'EAU DOUCE		0	0	0	10	6	145	22	244	149	576	161	28%	Juin 2012	
PAPILLONS DE JOUR		0	0	1	2	3	11	18	215	3	253	16	6%	Mars 2012	OPIE & SEF
LIBELLULES		0	0	2	1	3	7	13	62	1	89	11	12%	Mars 2016	OPIE & SFO
EPHEMERES		0	0	2	5	10	16	23	77	9	142	31	22%	Juil 2018	OPIE
MOLLUSQUES TER. & EAU DOUCE		0	0	2	12	25	42	32	293	285	691	79	11%	Juil 2021	
FLORE VASCULAIRE		2	0	22	51	132	238	321	3843	373	4982	421	8%	Dec 2018	FCBN & AFB
TOTAL **		5	0	39	107	230	534	531	5017	915	7378	871			

** Proportion d'espèces menacées calculée pour les groupes d'espèces évalués en totalité et comportant au moins 10 espèces.*
*** Hors oiseaux hivernants et de passage.*

Les catégories de l'UICN pour la Liste rouge

Espèces disparues :
EX : Eteinte au niveau mondial
EW : Eteinte à l'état sauvage
RE : Disparue au niveau régional

Espèces menacées de disparition :
CR En danger critique
EN En danger
VU Vulnérable

Autres catégories :
NT : Quasi menacée (espèce proche du seuil des espèces menacées ou qui pourrait être menacée si des mesures de conservation spécifiques n'étaient pas prises)
LC : Préoccupation mineure (espèce pour laquelle le risque de disparition est faible)
DD : Données insuffisantes (espèce pour laquelle l'évaluation n'a pas pu être réalisée faute de données suffisantes)

Source : UICN Comité français & MNHN (2022). La Liste rouge des espèces menacées en France. Paris, France.

IUCN, 2022[58]

Protecting biodiversity in France

The erosion of biodiversity is recognised as a major risk factor for the functioning of our human societies and for the stability of the economic system: a report by the French Ministry of Ecology estimates that at least 80% of employment depends on biodiversity, either directly or indirectly[59]. As a result, a number of policies have been put in place to encourage the monitoring, protection and restoration of biodiversity:

Table 5 Main policies for protecting biodiversity in France

Grenelle Environment Forum	A process initiated in 2008 to encourage and accelerate the consideration of environmental challenges in all sectors (energy and construction, transport, biodiversity and natural environments, governance, environmental and health risks).

[58] UICN, *La Liste rouge des espèces menacées en France*, 2022.
https://uicn.fr/wp-content/uploads/2022/12/resultats-synthetiques-liste-rouge-france.pdf
[59] Emmanuel Delannoy, *La biodiversité, une opportunité pour le développement économique et la création d'emploi*, 2016.
https://www.ecologie.gouv.fr/sites/default/files/DELANNOY_BIODIV_Rapport_Final_20161117.pdf

Habitat, Fauna and Flora Directive	European directive of 21 May 1992 for the protection of "remarkable" environments and species, serving as the legal basis for the Natura 2000 network by providing for the designation of Special Areas of Conservation (SAC) and the protection of species throughout mainland France.
Birds Directive	European directive of 2 April 1979 on the protection of wild birds, which serves as the legal basis for the Natura 2000 network, notably by providing for the designation of Special Protection Areas (SPAs) throughout mainland France.
Objectives document	Framework document validated by the Prefect, defining, for each Natura 2000 site, an inventory of the site, the management objectives and the procedures for implementing them.
Natura 2000	European ecological network of natural sites designated under the "Habitats" and "Birds" Directives, with the aim of conserving habitats and species of Community interest.

Source: OFB

In terms of biodiversity monitoring, production of the national Red List is coordinated by the UMS PatriNat (OFB-CNRS-MNHN) and the French IUCN committee. The role of the National Biodiversity Observatory (ONB) is to make available and disseminate reliable and regularly updated information on the state of biodiversity in France.

The Red List of threatened species in the Atlantic Arc

Based on the national Red List of Threatened Species, the authors of this report have drawn up a list of 19 "endangered" and "critically endangered" species (flora and fauna) that are likely to be impacted by the development of bioeconomy activities in the Atlantic Arc in connection with the value chain of the SCALE-UP project (fibre plants for use in bio-based construction). Many are located in the Pyrenean mountains and depend on a fragile natural environment.

Table 6 Red list of species likely to be impacted by the development of the bioeconomy as part of SCALE-UP in the Atlantic Arc

Name	Status	Description
Mercuria vindilica	Endangered	A species of the mollusc family, endemic to Belle-Île-en-Mer and living in freshwater. Threatened by water degradation and urbanisation.
Belgrandia conoidea	Endangered	Small freshwater snail, only known from two freshwater sites near Montauban. Threatened by water degradation and urbanisation.
Aster pyrenaeus	Endangered	A flowering plant found only in the Pyrenees, threatened by habitat fragmentation, abandonment of traditional land management, overgrazing and recreational activities.
Cobitis calderoni	Endangered	River fish, victim of habitat degradation (gravel extraction, water catchments) and the presence of invasive exotic species.

Halictus carinthiacus	Endangered	An insect whose range is fragmented and whose decline is linked to habitat degradation, climate change, changes in land use and urbanisation.
Metrioptera buyssoni	Endangered	A grasshopper endemic to the Pyrenees, whose population is highly fragmented. The causes of its decline are poorly identified, but can be attributed to climate change (droughts) and overgrazing.
Isoetes boryana	Endangered	An aquatic plant with a very limited range that is heavily impacted by eutrophication and water management.
Cryptazeca monodonta	Endangered	A small terrestrial snail endemic to the western Pyrenees that lives in damp habitats. Its habitat is very restricted and fragmented, and it is vulnerable to increasing drought.
Oxychilus basajauna	Endangered	Land snail native to Spain, threatened by urbanisation and changes to river margins.
Rana pyrenaica	Endangered	The Pyrenean frog population is in decline due to the degradation of its natural habitat.
Isoetes tenuissima	Endangered	Aquatic species threatened by the degradation of its habitat, present in protected areas.
Sphegina limbipennis	Endangered	A flying insect found in the Pyrenees and the Armorican Basin, threatened by intensive farming practices, climate change and habitat degradation.
Chrysogaster rondanii	Endangered	A flying insect whose decline is linked to forest management, groundwater abstraction, nitrogen and pesticide deposits, and climate change.
Microdon major	Endangered	A flying insect with a restricted and fragmented range, threatened by habitat degradation.
Sphegina atrolutea	Endangered	A flying insect found in the Pyrenees, in forested areas with watercourses. Its habitat is threatened by agricultural and recreational practices, as well as by forestry operations.
Sphegina varifacies	Endangered	A flying insect whose distribution is severely fragmented, threatened by the intensification of forestry and water management.
Pseudunio auricularius	Critically endangered	The population of this river mussel has been reduced by 90% in 30 years due to river development and water abstraction, causing fragmentation and degradation of its habitat.
Corticeus bicoloroides	Endangered	A beetle found in the Pyrenees that thrives in dead wood. It is threatened by intensive forestry and farming practices.
Galemys pyrenaicus	Endangered	The Pyrenean Desman is a small mammal whose population is thought to have fallen by 50% over the last 10 years. The reasons for this decline are not well known, but are probably linked to human activities and the proliferation of invasive exotic species in its habitat.

Given the current pressures on biodiversity, any bioeconomy activity must take account of its potential impact and limit it. Activities that protect and restore biodiversity should be encouraged.

2 Methodology for the appraisal of available capacity of the regional ecosystem

This section describes the methodology that has been applied by the authors of this report to assess the water, soil and biodiversity resources in the French Atlantic Arc, and the conclusions regarding ecological boundaries in this area.

2.1 Water data and indicators

To run the sustainability screening of surface and groundwater bodies potentially relevant to the macro-region of the French Atlantic Arc, the authors of this report have reviewed the data reported in the 2nd River Basin Management Plan of the Adour-Garonne, Loire-Brittany, and Seine-Normandy River Basin Districts published in 2016 (data from the 3rd reporting cycle was not yet available on the WISE Data-base at the time of the analysis). The benefits of tapping on this reporting process is that it includes well-defined indicators like the status of water bodies in each river basin district as well as data on significant pressures and impacts on them. Further, these data are official, largely available, accessible, and updated periodically (every six years).

2.1.1 Description of the data / definition of the indicators employed

Data reviewed for this part of the screening included the reported ecological and chemical status of rivers and lakes as well as the quantitative and chemical status of groundwater bodies in the river basin districts in the Atlantic Area. These data give indications on water quality in the river basins according to the five status classes defined in the WFD. These are: high (generally understood as undisturbed), good (with slight disturbance), moderate (with moderate disturbance), poor (with major alterations), and bad (with severe alterations) (EC, 2003). Further, data on significant pressures and significant impacts on the water bodies in the river basin districts are used to indicate the burden of specific pressure and impact types on water ecosystems in the regions based on the number and percentage of water bodies subject to them. Significant pressures are defined as the pressures that underpin an impact which in turn may be causing the water body to fail to reach at least the good status class (EEA, 2018).

All data described above were accessed on 11.10.2023 from the WISE WFD data viewer (Tableau dashboard) hosted on the European Environment Agency's website[60].

Table 7 Indicators used for the water component of the sustainability screening

Category	Indicator Family	Indicator	Spatial level	Unit of measure	Comments/Reference
Water	Water quality	Status of water bodies according to the EU Water Framework Directive	River Basin District	Number of water bodies in high, good, moderate, poor, bad or unknown status	WISE WFD Data Viewer[61] Disaggregated data for ecological and chemical status of surface water bodies; quantitative and chemical status of groundwater bodies, per River Basin District

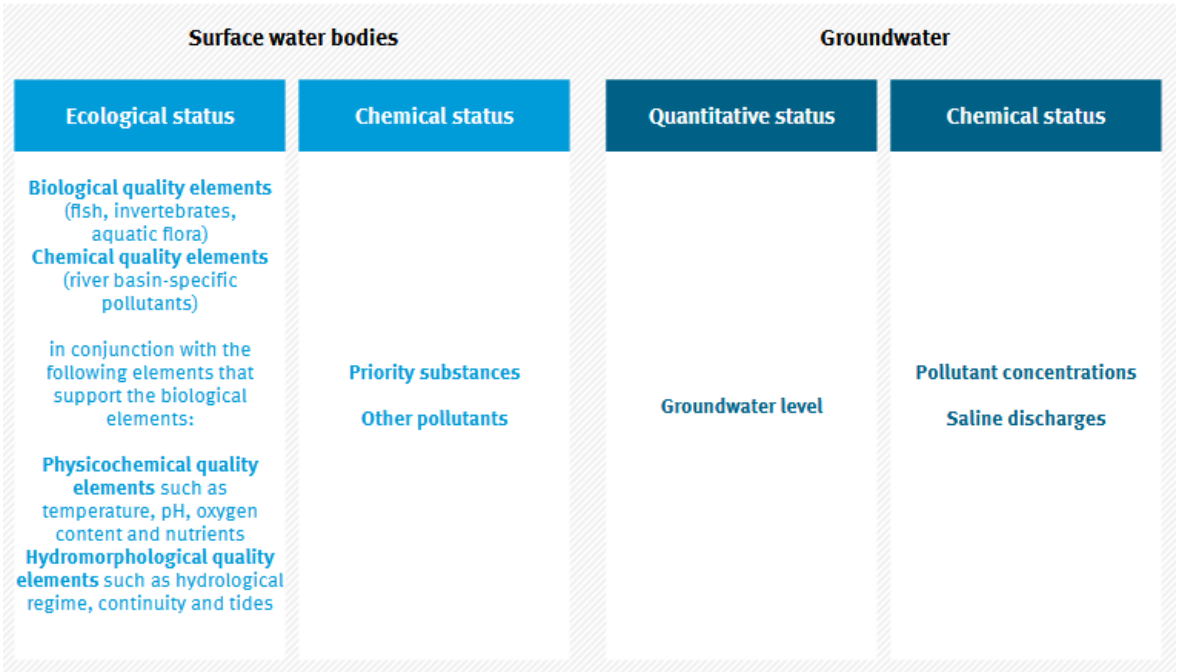
[60] https://www.eea.europa.eu/data-and-maps/dashboards/wise-wfd
[61] WISE WFD Data Viewer (https://www.eea.europa.eu/data-and-maps/dashboards/wise-wfd)

	Burden on water bodies	Significant pressures on water bodies	River Basin District	No. and % of water bodies under significant pressures per pressure type	WISE WFD Data Viewer
	Burden on water bodies	Significant impacts on water bodies	River Basin District	No. and % of water bodies under significant impacts per impact type	WISE WFD Data Viewer

Source: Anzaldúa et al., 2022.

To determine which status class a certain water body falls into, WFD assessments evaluate the *ecological* and *chemical* status of surface waters (i.e. rivers and lakes) and the *quantitative* and *chemical* status of groundwater bodies. Ecological status refers to *"an expression of the quality of the structure and functioning of aquatic ecosystems associated with surface waters"*. It covers assessments of biological (e.g. presence and diversity of flora and fauna), physico-chemical (e.g. temperature and oxygen content) and hydromorphological criteria (e.g. river continuity) (EC, 2003; BMUB/UBA, 2016). The chemical status of a surface water body is determined by comparing its level of concentration of pollutants against pre-determined environmental quality standards established in the WFD (concretely in Annex IX and Article 16(7)) and in other relevant Community legislation. These standards are set for specific water pollutants and their acceptable concentration levels.
In the case of groundwater bodies, chemical status is determined on the basis of a set of conditions laid out in Annex V of the WFD which cover pollutant concentrations and saline discharges. Additionally, the water body's quantitative status is included in the WFD assessments, defined as "*an expression of the degree to which a body of groundwater is affected by direct and indirect abstractions"*. This gives indication on groundwater volume, a relevant parameter to evaluate hydrological regime (BMUB/UBA, 2016).

Figure 19 Overview of surface water body and groundwater status assessment criteria, as per the Water Framework Directive.



Source: BMUB/UBA, 2016.

In the case of surface water bodies, the WFD objective is not only that they reach good status, but that quality does not deteriorate in the future (EC, 2003), which is relevant in the context of the development of bioeconomy value chains.

2.1.2 Methodology applied

The authors of this report have devised an approach to valorise the data from the WFD reporting described in the previous sub-section that allows for an appraisal that is non-resource intensive (based on reliable, publicly available and accessible data) yet capable of providing a rough overview of the state of the Atlantic Arc's waters. This is in line with the rationale of this sustainability screening, which aims to enable stakeholders with limited financial resources and/or expertise in the field to consider ecological limits in a structured manner when developing bioeconomy activities. The preferred option for this part of the assessment would have been to supplement the WFD data with a water quantity balance indicator like the Water Exploitation Index plus (WEI+) developed by the EEA and its partners. That indicator compares the total fresh water used in a country per year against the renewable freshwater resources (groundwater and surface water) it has available in the same period. This could have strengthened the water quantity element in the screening. However, the calculation of the WEI+ at regional level is currently not conducted or foreseen by its developers, and it would entail a disproportionately large effort that falls beyond the scope of this task in SCALE-UP. For these reasons, the reported data from the WFD process has been employed exclusively within the following methodology.

The overall apportionment of rivers, lakes and groundwater bodies in the Atlantic Arc according to their WFD status classification can be used to set the baseline for the sustainability screening. It provides initial insight on the situation in the demarcation as regards "ensuring access to good quality water in sufficient quantity", "ensuring the good status of all water bodies", "promoting the sustainable use of water based on the long-term protection of available water resources" and "ensuring a balance between abstraction and recharge of groundwater, with the aim of achieving good status of groundwater bodies", all explicit aims of the WFD that are aligned with the consideration of ecological limits. Further, the data on significant impacts and pressures affecting the water bodies in the river basins are useful as they can point towards specific problems (e.g. nutrient pollution) and the types of activities that may be causing them (e.g. discharge of untreated wastewater, agriculture).

As a first step, the approach used for this element of the screening entails calculating what proportion of the total number of surface water bodies located in the RBD is reported as failing to achieve Good Ecological Status/Good Chemical Status or for which conditions are unknown. Similarly for groundwater bodies, the proportion is calculated of those who are reported as failing to achieve Good Chemical Status/Good Quantitative Status or for which conditions are unknown. The resulting ratios are then compared to the respective EU proportions, which are used as (arbitrary) thresholds. According to the latest assessment published by the EEA in 2018, "around 40% of surface waters (rivers, lakes and transitional and coastal waters) are in good ecological status or potential, and only 38% are in good chemical status" (EEA, 2018). Accordingly, "good chemical status has been achieved for 74% of the groundwater area, while 89% of the area achieved good quantitative status" (EEA, 2018). Using these markers, the following step is to rank the current conditions of the French Atlantic Arc using an ordinal risk rating (high, moderate, low) based on the distance of the result of each indicator to the EU level results. On this basis, the thresholds and ordinal ranking convention suggested by the authors of this report are as shown in Table 8 and Table 9.

Table 8 Proposed thresholds for the water section of the sustainability screening

Water body type	Status category	2018 EU-level assessment results (proportion of water bodies achieving good status)	Proposed thresholds for the sustainability screening		
			High concern	Moderate concern	Low concern
Surface water bodies	Ecological status	~40%	0-40%	41-89%	90-100%
	Chemical Status	38%	0-38%	39-89%	90-100%
Groundwater bodies	Chemical status	74%	0-74%	75-89%	90-100%
	Quantitative status	89%	0-89%	-	90-100%

Source: Anzaldúa et al., 2022.

Table 9 Ordinal ranking convention for the water section of the sustainability screening

Ordinal ranking for water resources		Chemical status		
		High concern	Moderate concern	Low concern
Ecological or Quantitative status	High concern			
	Moderate concern			
	Low concern			

Source: Anzaldúa et al., 2022.

This initial appraisal based on the thresholds shown above is then supplemented with a review of the reported data on the types of significant pressures and impacts on surface and groundwater bodies. In this case percentage values are already given, and so this step in the screening simply entails the listing of the reported pressures and impacts and the identification of those which are more frequently reported. From here, the screening team can seek potential correlations between the most reported pressure types and the most reported impact types (e.g. diffuse sources causing nutrient pollution).

The final step in the approach is to draft a note describing the share of water bodies failing to reach good status and formulating preliminary statements on the types of bioeconomy activities that could be considered, those that should be considered with reserve, and those that should be avoided. These initial statements are intended to frame the discussion of the group of stakeholders involved in the development of the bioeconomy value chains in focus in the SCALE-UP project.

2.1.3 Data uncertainties

The data resulting from the assessments reported in the French Atlantic Arc and subsequently in WISE are subject to the limitations of the scientific and methodological approaches used by their authors. It thus must be considered that the official assessments are based on estimates, include assumptions, and will therefore carry a margin of error.

An important limitation bound to the implementation of the sustainability screening is that the WFD data used cover a larger area than that of the French Atlantic Arc region (see maps on page 11 "*Overlay of the boundaries of the four administrative regions in the French Atlantic Arc against the River Basin Districts they lie in"*). Therefore, the data used on the qualitative and quantitative status of water in the three river basins covers other neighbouring regions. Consequently, where possible, these data have been supplemented by data and contextual elements from the literature review (see references at the end of the document), based on official sources (Water Agencies of the basin districts, French Biodiversity Agency, groups of experts mandated by the regional councils such as the IPCC in Pays de la Loire and AcclimaTerra in New-Aquitaine).

Lastly, another issue to consider is the data currently available on WISE is from 2016, while more updated (interim) assessments are already available at the time of writing of this document. These come as part of the 3rd cycle of river basin management planning (2022-2027) but not already publicly available. The data used from the literature review is mainly based on state of water quality in the water districts in 2020, based on data from 2016-2017.

2.1.4 Methodological uncertainties

The proposed methodology for the water section used in this application of the sustainability screening is straight-forward and accessible, yet it must be used with care and, where possible, should incorporate higher resolution data evaluated by thematic experts. As previously mentioned, the thresholds set in this case have been the proportions, at EU-level, of water bodies that fail to achieve good status or for which conditions have been reported as unknown.

2.2 Soil data and indicators

2.2.1 Description of the data / definition of the indicators employed

The selected indicators for vulnerability to soil depletion are closely interrelated and refer specifically to soil erosion **by water**. These are:

- Estimated mean soil erosion rate (in $t\ ha^{-1}\ a^{-1}$)
- Share (%) of area under severe erosion (>10 $t\ ha^{-1}\ a^{-1}$)

In broad terms, soil erosion describes the process through which land surface (soil or geological material) is worn away (e.g. through physical forces like water or wind) and transported from one point of the earth surface to be deposited somewhere else (Eurostat, 2020). The above-mentioned indicators describe particularly the amount of soil (in t) per unit of land surface (in ha) that is relocated by water per year.

Variations of these indicators can be calculated by considering different combinations of land cover classification groups, such as *all land*[62] and *agricultural land*[63]. As shown in 14, at EU level in 2016, about three quarters of soil loss occurred in agricultural areas and natural grasslands, while the remaining quarter occurred in forests and semi natural areas (Eurostat, 2020). Therefore, since it is the type of land cover that is most vulnerable to erosion, the present sustainability screening will consider in first line the above-mentioned indicators specifically for agricultural areas and natural grasslands. This scope of the indicators is also in line with the two sub-indicators for soil erosion considered by the Joint Research Centre European Soil Data Centre (JRC ESDAC). Moreover, both the *mean erosion rate for agricultural land* and the *share of agricultural area under severe erosion* are part of the EU Common Agriculture Policy (CAP) context indicator 42 (CCI42) for the period 2014-2020.

Figure 20 Share of land cover and soil loss across the EU-27 in 2016[64]

Source: JRC, Eurostat

The data has been extracted from EUROSTAT, specifically the dataset “Estimated soil erosion by water, by erosion level, land cover and NUTS 3 regions (source: JRC) (aei_pr_soiler)”. For determining the baseline in the sustainability screening, we have selected the latest available data, i.e. for 2016.

Mean soil erosion rate, which undergirds both selected indicators, is considered useful because it provides a solid baseline to estimate the actual erosion rate in the regions (Panagos et al., 2015). This indicator is based on the latest Revised Universal Soil Loss Equation of 2015 (RUSLE2015), specifically adapted for the European context (see Panagos et al., 2015), which is a model that takes into account various aspects, including two dynamic factors, namely the cover-management[65] and policy support practices[66] (both related to human activities) (Panagos et al., 2020).

The estimated mean soil erosion rate value obtained through the RUSLE2015 model refers to water erosion only, but it is considered to be the most relevant at least in terms of policy action at EU level,

[62] This refers to all potentially erosive-prone land (in simplified terms), specifically to CORINE Land Cover classification groups: Agricultural areas (2), forest and semi natural areas (3) excluding beaches, dunes, sand plains (3.3.1), bare rock (3.3.2), glaciers and perpetual snow (3.3.5). These, as well as other classes, are excluded because they are not subject to soil erosion.
[63] This refers only to agricultural land (agricultural cropland as well as grassland in simplified terms), specifically to CORINE Land Cover classification groups: Agricultural Areas (2) and Natural Grasslands (321)
[64] Excluding not erosion-prone land (e.g. beaches, dunes, etc.). Forest and natural areas exclude also natural grasslands, which are evaluated together with agricultural areas.
[65] Known as the c-factor, it has a non-arable component, which includes changes in land cover and remote sensing data on vegetation density, as well as an arable component, which includes Eurostat data on crops, cover crops, tillage and plant residues
[66] Known as the p-factor, it reflects the effects of supporting policies in estimating the mean erosion rate by including data reported by member states on Good Agricultural Environmental Conditions (GAEC) according to the CAP, specifically contour farming, as well data from LUCAS Earth observation on stone walls and grass margins

due to the relative predominance of water erosion over other types of erosion. Furthermore, it offers the important advantage of providing a viable estimation for erosion vulnerability at a relatively small geographic scale, i.e. the local or regional level. This can serve as an important tool for monitoring the effect of local and regional policy support strategies of good environmental practices (Panagos et al., 2015, 2020 and Eurostat, 2020).

2.2.2 Methodology applied

The near-universal indicators available to track soil vulnerability are related to either erosion or the decline in soil organic carbon (SOC)/soil organic matter (SOM) (Karlen & Rice, 2015). However, there are major data gaps regarding to SOC/SOM and data is currently only available at national level. According to Panagos et al. (2020), soil organic carbon does not change so quickly and therefore is not so sensitive to human influence on short term. Therefore, they recommend using just a sole indicator for monitoring impact of policies: “estimated mean soil erosion rate” (by water), which they calculate using the RUSLE2015 model. For our purposes, we have complemented the *mean soil erosion rate* indicator, with the *share of agricultural area under severe erosion* in order to gain a comprehensive picture of soil erosion in a region.

Soil erosion is considered generally as a sort of proxy indicator of soil degradation, which in turn is the most relevant component of land degradation at EU level (EC, 2018). However, not all types of bio-based activities have a direct effect on erosion, but rather primary production of biomass. Nonetheless, as these are currently the most widespread bioeconomy activities in rural areas, we will consider their impact on soil degradation, and therefore on soil erosion, to be the most relevant one for this assessment.

The indicators for vulnerability to soil degradation were selected, on one hand, due to the limited number of soil indicators available at the required regional scale. On the other hand, the RUSLE2015 model used for this data also represents the current state-of-the-art methodology for calculating soil erosion. These aspects are crucial, since the choice of indicators needs to be: a) acceptable to experts, b) routinely and widely measured, and c) have a currency with the broader population to achieve global acceptance and impact (Stockmann et al., 2015). In order to carry out the screening of soil vulnerability, a number of datasets need to be accessed. As mentioned above, this data can be accessed via Eurostat.

In terms of processing the erosion data, it is important to consider that the overall erosion rate changes across geographic areas, meaning the vulnerability/risk is not necessarily evenly distributed. In cases where the mean soil erosion rate exceeds the 10 t ha^{-1} a^{-1}, erosion is considered severe and activities that can generate, or are associated with a high erosion impact should be strongly discouraged. Erosion rates between 5 and 10 t ha^{-1} a^{-1} are considered moderate, requiring some attention towards practices that have a high impact on erosion, but with less urgency. However, it is relevant to take a look not only at the mean erosion rate for the area itself, but also at its spatial distribution, which is roughly reflected on the indicator of share of (agricultural) area under severe erosion.

2.2.3 Data uncertainties

The data used is produced from an empirical computer model (RUSLE2015) and produces estimates. Hence, there are several uncertainties related to the figures if compared to data collected on the ground. However, the purpose of the model is to generate data for a large spatial scale taken into account human intervention, which is not possible to do only through empirical measurements. That being said, like every model, assumptions have to be made and there is an intrinsic level of uncertainty. Specifically related to the RUSLE methodology, Benavidez et al. (2018) critically reviewed the RUSLE methodology, upon which RUSLE2015 is based, and identified following main limitations:

- its regional applicability to regions that have different climate regimes and land cover conditions than the ones considered (in the original RUSLE for the USA, in RUSLE 2015 for Europe)
- uncertainties associated generally with soil erosion models, such as their inability to capture the complex interactions involved in soil loss, as well as the low availability of long-term reliable data and the lack of validation through observational data of soil erosion, among others.
- issues with input data and validation of results,

- its limited scope, which considers only soil loss through sheet (overland flow) and rill erosion, thus excluding other types of erosion which may be relevant in some areas, e.g. gully erosion and channel erosion, to name a few. Moreover, it also excludes wind erosion.

A further factor of uncertainty in the data is the fact that the RUSLE model is calculated using mean precipitation data over multiple years and a large territorial scale (in this case Europe). Thus, it fails to account the changes in rainfall intensity, which are highly relevant for determining water erosion accurately. This is the case not only considering the seasonality of rainfall, but also its distribution across the continent (Panagos et al., 2020). Another important uncertainty identified by Panagos et al. (2020) is the lack of georeferenced data for annual crops and soil conservation practices in the field at a continental level, which has had to be estimated from statistical data.

Nonetheless, when considered best available estimates, the mean soil erosion values generated through the application of RUSLE2015 model offer a very suitable basis for assessing vulnerability to soil loss in general terms, even if the generated absolute values are to be taken with caution (Benavidez et al., 2018).

2.2.4 Methodological uncertainties

Among the most relevant uncertainties regarding the application of the sustainability screening in terms of soil vulnerability are the selection of the threshold against which the severity of erosion is evaluated and the selection of the land cover types that will be considered.

Regarding the threshold of 10 t ha^{-1} a^{-1} for severe erosion, it is important to mention that this was obtained directly from the dataset that was used[67]. However, it is still an arbitrary value which can be adapted. For instance, some sources like Panagos et al. (2015, 2020), who were involved in the generation of the data for the JRC ESDAC, consider severe erosion to be above 11 t ha^{-1} a^{-1}. In this regard, we have also decided to stick to the lower value described in the Eurostat dataset because it is more conservative and, as such, more suitable for an initial (and indicative) sustainability screening like the one we are proposing.

The selection of land cover types presents another area for potential uncertainty. Choosing between “all lands” and “agricultural lands” can have considerable implications for interpreting the data. For example, it is possible that the mean soil erosion rate is 5 t ha^{-1} a^{-1} (moderate erosion) in one land cover type, but lower in the other. This would have an effect on the assessment, which would present any potential concerns about erosion and steps that should be taken. As such, it is important to have solid grounding for the choice of dataset. The ultimate decision whether to consider all lands (including forests) is arbitrary and lays with the group performing the sustainability screening. Particularly when that decision is based on considerations of the economic relevance of forestry related industries in the region rather than on the actual share of the area that is covered with forest (it should be high to justify their inclusion), the values of soil erosion (for all lands) shall be taken with some reservations. This is because these values tend to be lower than the value for agricultural land and can create the impression that vulnerability to erosion is lower than it actually is. However, due to the indicative (and non-exhaustive) nature of the present sustainability screening, this uncertainty is not especially relevant for cases such as the French Atlantic Arc, where both values (for all lands and agricultural land with natural grassland) are low with regard to the methodology used.

However, it is important to mention that the experts consulted on the subject (Seine-Normandie Water Agency, Pays de la Loire Regional Council) take the issue of soil very seriously and consider the problems of soil quality and of soil erosion to be very real issues in the Atlantic Arc regions, on which action needs to be taken.

[67] See metadata of the used dataset at https://ec.europa.eu/eurostat/cache/metadata/en/aei_pr_soiler_esms.htm

2.3 Biodiversity data and indicators

2.3.1 Description of the data / definition of the indicators employed

Unlike for water- and soil-related risks, there are no reliable indices or standardized metrics to operationalize and compare risks to biodiversity at the regional level and in an integrated manner. Biodiversity is intricate and multifaceted, spanning genetic, species, and ecosystem diversity across various regions. Attempting to consolidate this diversity into a singular index may oversimplify it, leading to the loss of crucial information (Ledger et.al 2023; Brown & Williams 2016). Instead, biodiversity risks in a given region could be uncovered by considering the status of all species known to inhabit the region under scrutiny on a one-by-one basis, without trying to synthesize their collective status in a single index. Accordingly, our methodology suggests screening for biodiversity risks of a region by taking stock of its species of flora, fauna and fungi present in the demarcation and considering their conservation status. The Red List of Threatened Species of *the International Union for Conservation of Nature* (IUCN) is a globally recognized system for classifying the conservation status of species[68]. It is structured along the following risk categories (IUCN 2001, 2003):

(1) Critically Endangered (CR): This is the highest risk category assigned by the IUCN Red List for wild species. Species in this category are facing an extremely high risk of extinction in the wild.
(2) Endangered (EN): Species in this category are facing a high risk of extinction in the wild.
(3) Vulnerable (VU): Species in this category are facing risks of extinction in the wild.
(4) Near Threatened (NT): Species in this category are close to qualifying for, or are likely to qualify for, a threatened category soon.
(5) Least Concern (LC): Species in this category have been evaluated but do not qualify for any other category. They are widespread and abundant in the wild.
(6) Data Deficient (DD): A category applied to species when there is inadequate information to make a direct or indirect assessment of its risk of extinction based on its distribution or population status.
(7) Not Evaluated (NE): A category applied to species that have not yet been evaluated against the criteria (IUCN 2001, 2003)

Data description

Data on the risk category of each species found in the SCALE-UP regions is accessed through the online database of the IUCN Red List website. The IUCN Red List serves as a comprehensive repository of information, offering insights into the present extinction risk faced by assessed animal, fungus, and plant species. In 2000, IUCN consolidated assessments from the 1996 IUCN Red List of Threatened Animals and The World List of Threatened Trees, integrating them into the IUCN Red List website with its interactive database, currently encompassing assessments for over 150.300 species. Since 2014, assessors of species have been mandated to furnish supporting details for all submitted assessments. Among the recorded details are the species' (1) IUCN Red List category, (2) distribution map, (3) habitat and ecology, (4) threats and (5) conservation actions. The assessment of these dimensions is elaborated below:

(1) The IUCN Red List category: The IUCN Red List categories (CR, EN, VU, NT, LC, DD, NE) are determined through the evaluation of taxa against five quantitative criteria (a-e), each grounded in biological indicators of population threat:

[68] The International Union for Conservation of Nature (IUCN) is a global environmental organization that was founded on October 5, 1948. It is the world's oldest and largest global environmental network. The IUCN works to address conservation and sustainability issues by assessing the conservation status of species, promoting sustainable development practices, and providing guidance and expertise on environmental policy and action. The IUCN also plays a crucial role in influencing international environmental policies and fostering collaboration among governments, NGOs, and the private sector to promote conservation efforts worldwide (IUCN 2018).

a. Population Size Reduction: This criterion evaluates the past, present, or projected reduction in the size of a taxon's population. It considers the percentage reduction over a specific time frame, with different thresholds indicating different threat levels.
b. Geographic Range Size and Fragmentation: This criterion assesses the size and fragmentation of a taxon's geographic range. Factors such as few locations, decline, or fluctuations in range size contribute to the evaluation.
c. Small and Declining Population Size and Fragmentation: This criterion focuses on taxa with small and declining populations, considering factors like population size, fragmentation, fluctuations, or the presence of few subpopulations.
d. Very Small Population or Very Restricted Distribution: This criterion addresses taxa with extremely small populations or limited distributions. It assesses whether the taxon is at risk due to its small population size or restricted geographic range.
e. Quantitative Analysis of Extinction Risk: This criterion involves a quantitative analysis, such as Population Viability Analysis, to estimate the extinction risk of a taxon. It considers various factors influencing population dynamics and extinction risk.

While listing requires meeting only one criterion, assessors are encouraged to consider multiple criteria based on available data. Quantitative thresholds of the IUCN Red List categories were developed through wide consultation and are set at levels judged to be appropriate, generating informative threat categories spanning the range of extinction probabilities. To ensure adaptability, the system permits the incorporation of inference, suspicion, and projection when confronted with limited information.

(2) The distribution map: The IUCN Red List distribution map serves as a reference for the taxon's occurrence in form of georeferenced data and geographic maps. This data is available for 82% of the assessed species (>123.600) and is based on the species' habitat, which is linked to land cover- and elevation maps. The indicated area marks the species extent of occurrence, which is defined as the area contained within the shortest continuous imaginary boundary which can be drawn to encompass all the known, inferred, or projected sites of present occurrence of a species, excluding cases of vagrancy. This measure may exclude discontinuities or disjunctions within the overall distributions of species, such as large areas of obviously unsuitable habitat. For a detailed explanation of the mapping methodology, please refer to the *Mapping Standards and Data Quality for the IUCN Red List Spatial Data* (IUCN 2021).

(3) Habitat and Ecology: The IUCN classifies the specific habitats that a species depends on for its survival. These habitats are categorized into three broad systems: terrestrial, marine, and freshwater. A species may inhabit one or more of these systems, and so the possible permutations result in seven categories of natural systems. Beyond these seven system categories, the IUCN offers a more nuanced classification system for habitats, comprising 18 different classes at level 1 (e.g., forest, wetlands, Grassland, etc.), and 106 more specific classes listed at level 2 (e.g., Forest – Subtropical/tropical moist lowland, Wetlands (inland) – Permanent inland deltas; Grassland - Temperate) (IUCNa n.d.). For SCALE-UP's sustainability screening, the IUCN classification of the seven systems is sufficient to refine the search while not excluding relevant habitats. The EU Habitats Directive, in contrast, distinguishes 25 habitat types that are considered threatened and require active and recurring conservation action. The directive demands member states to take measures to maintain or restore these natural habitats and wild species.

(4) Threats: The IUCN database encompasses various general threats that can negatively impact a species. Direct threats denote immediate human activities or processes impacting, currently impacting, or potentially affecting the taxon's status, such as unsustainable fishing, logging, agriculture, and housing developments. Direct threats are synonymous with sources of stress and proximate pressures. Assessors are urged to specify the threats that prompted the taxon's listing at the most granular level feasible within this hierarchical classification of drivers. These threats could be historical, ongoing, or anticipated within a timeframe of three generations or

ten years. These generalized threat categories encompass residential and commercial development, agriculture and aquaculture, energy production and mining, transportation and service corridors, biological resource use, human intrusion and disturbances, natural system modifications, invasive and other problematic species, genes and diseases, pollution, geological events, and climate change and severe weather. Beneath each general threat, more specific threats are detailed. Please refer to the hyperlink in footnote[69] for a detailed list of all threats including explanations.

(5) Conservation Actions: The IUCN database contains conservation action needs for each species, providing detailed information on the current conservation efforts and recommended actions for protecting the taxon. It includes general conservation actions such as research & monitoring, land/water protection, management, and education. Specific conservation actions are listed under each general action, along with a description of the current conservation status and recommended actions to protect the taxon. A hierarchical structure of conservation action categories (see footnote[70]) indicates the most urgent and significant actions needed for the species, along with definitions, examples, and guidance notes on using the scheme. Assessors are encouraged to be realistic and selective in choosing the most important actions that can be achieved within the next five years, informed by the conservation actions already in place.

IUCN Red List and Habitat Directive

Both, the EU's Habitats Directive and the IUCN Red List aim to preserve biodiversity, but they employ distinct methods and standards for evaluating conservation status. The Habitats Directive is centered on preserving natural habitats and wild species of flora and fauna within the European Union, mandating that member states establish Special Areas of Conservation for habitats and species listed in its annexes. The Directive categorizes conservation status into three groups: favorable, unfavorable-inadequate, and unfavorable-bad. This classification system of habitats and species is based on how far they are from the defined 'favorable' conservation status, not their proximity to extinction (Sundseth 2015).

Conversely, the IUCN Red List is a worldwide evaluation of the conservation status of species, categorizing them according to their extinction risk. The Red List employs a set of five rule-based criteria to assign species to a risk category (see above). However, there are inconsistencies and weak agreement between the conservation status assessments of the Habitats Directive and the IUCN Red List. These inconsistencies can be significant, and correlations can vary greatly between taxonomic groups. Specifically, the Red List assessment tends to be more pessimistic than the Directive's Annex (Moser et.al 2016). Amos (2021), on the other hand, has found strong correlations between the two classifications systems for plants, while recognizing the Red List's quicker reaction to changes in the conservation status.

In summary, while both the Habitats Directive and the IUCN Red List aim to protect and conserve biodiversity, they use different methodologies and criteria to assess conservation status, leading to discrepancies in their assessments. However, they can complement each other in providing a comprehensive view of the conservation status of species and habitats at both the European and global levels (IUCN 2010).

[69] https://www.iucnredlist.org/resources/threat-classification-scheme
[70] https://www.iucnredlist.org/resources/conservation-actions-classification-scheme

2.3.2 Methodology applied

The methodology aims to derive a list of species which would require special consideration (e.g. close monitoring and safeguarding) in the context of implementing bioeconomy activities. To generate this list, the search function of the interactive IUCN database is used following five steps:

(1) Scope of Assessment: Selection of Europe as the scope of assessment to evaluate the conservation status of the European population rather than the global population. This approach ensures that species are identified as threatened based on their status in Europe, irrespective of their global abundance.

(2) Geographical Delineation: Utilization of the interactive map of the IUCN database to draw a polygon that exceeds the region of interest. Exceeding the regions ensures that the entire region is covered, as it is not possible to draw a polygon exactly matching the boundaries of the region. Moreover, a larger polygon also respects the uncertainty of delineating a species area of extent, since the actual area of extent is possibly more fluid than its statically indicated geolocations Consequently, the larger polygon minimizes the risk of excluding any relevant species for which geolocations are registered just minimally outside of the regions' administrative boundaries, but which could inhabit parts of the region in future. There is no rule of thumb for a correct distance between polygon boundary and region boundary, but it would be advisable to keep this distance below 100 km.

(3) Species Selection: Limiting of the search results to endangered and critically endangered species to focus on those facing the most severe risks.

(4) Habitat Selection: selection of all habitats to ensure the full coverage of habitat types present in the geographical delineation defined in step 2.

(5) Threat Selection: Selection of threats associated with the respective regional bioeconomy and/or value chain to refine the search results to species likely to be impacted by them.

By following these steps, a targeted list of species is derived, focusing on species facing significant risks within the context of the regional bioeconomy strategy or value chain being explored, aligning with the specific conservation and bioeconomic priorities of the region.

2.3.3 Data and methodological uncertainties

It is important to acknowledge certain limitations and uncertainties associated with the data and methodologies used:

(1) Inaccurate representation of relevant area: The IUCN database allows for the interactive drawing of a map for a regional assessment. However, this drawn map might not accurately represent the area directly relevant to the bioeconomy strategy or value chain being explored. Since the selected polygon is larger than the actual bioregion, the assessment risks to include species that are not relevant to the bioregion and the bioeconomic strategy of the region.

(2) Lack of local habitat differentiation: The spread of species is indicated as its extent of occurrence without differentiating between habitats at the local level. This means that certain species might solely inhabit very particular habitats within the indicated extent of occurrence. An endangered amphibious species, for instance, might have an area of extent covering an entire country. However, it will only be found in very rare habitats within this area of extent (e.g., pond with very specific qualities). Accordingly, a regional assessment as outlined here (e.g., at the municipal level) might list certain species that do not occur in the assessed regions due to a lack of suitable habitats on the local level.

(3) Potential oversights in conservation status: Using Europe as a scope of assessment might hide any problematic conservation status of a species at the global or at the local level.

(4) Outdated data: The IUCN aims to have the category of every species re-evaluated at least every ten years and aims to update the list every two years (IUCNb n.d.). Nevertheless, the

data might be outdated, which could lead to inaccuracies in the assessment of biodiversity risks. For the screenings carried out in SCALE-UP, X% of the data was older than 5 years.

(5) Incomplete data: The data might be incomplete, which could limit the comprehensiveness of the assessment.

(6) Limited species coverage: It is estimated that the world hosts about 8,7 million species (Sweetlove 2011). As of now, more than 150.300 species (16.120 in Europe) have been assessed for the Red List, leaving large data gaps at the global level.

(7) Taxonomic standards: The taxon being assessed must follow the taxonomic standards used for the IUCN Red List. Any deviation from these standards could lead to inaccuracies in the assessment.

3 Potential ecological burden of regionally relevant bioeconomic activities

3.1 Bioeconomic activity selected for the screening

The project strategy formulated for the French Atlantic Arc explores the use of fibrous plants (straw, hemp, miscanthus, flax) for sustainable use in bio-based materials for the building industry. We have therefore carried out a sustainability screening of the cultivation and use of these crops, to identify potential environmental impacts associated with this value stream. Given the relatively specific field, literature on the topic remains somewhat limited, and is focused moreso on the cultivation of these crops, rather than their uses in bio-based products.

The following sections provide some working definitions and an overview of cultivation practices (more detailed information is available in the SCALE-UP report of the "Task 2.3 Regional Biomass and Nutrient Availabilities - Study on the availability of biomass for the bio-based building value chain in the French Atlantic Arc"). The rest of this chapter aims to synthesise the results of a literature review on potential impacts of cultivation of hemp, miscanthus and flax on water, land, and biodiversity, respectively.

3.2 Overview of straw/hemp/miscanthus/flax cultivation and their potential burden on the resources examined

3.2.1 Definitions

Straw: residue from the harvesting of cereal crops, when the grain is separated from the stalk.

Hemp: annual plant in the *Cannabinaceae* family. The only subspecies of hemp grown is the *cannabis sativa*, containing a low THC content (< 0.2%), as hemp is subject to strict regulations and only certified seed is authorised.

Miscanthus: perennial rhizomatous grass of the C4 type[71], originating from Central Asia.

Flax: annual herbaceous plant with blue flowers and oleaginous seeds.

Fibrous plant: plants cultivated for their fibres, traditionally used to make paper, fabric or rope, but nowadays their uses are diversifying to include applications in biobased materials for a variety of applications (bioplastics, insulation, etc.).

Bio-based materials: derived from renewable organic matter (biomass) of plant or animal origin, bio-based materials can have a wide range of applications in the bioeconomy. In the French Atlantic Arc for the SCALE-UP project, we specifically look into the bio-based materials from fibre plant, for the building industry market, mainly for insulation.

3.2.2 Overview of straw, hemp, miscanthus and flax cultivation and common management practices

Table 10 Fibrous plant common management practices	
Straw	• Cultivation: between October and August for winter wheat (wheat straw is the only one to have professional rules for applications in biobased construction, which is why we are only dealing with this one).

[71] It has a C4-type photosynthetic metabolism. C4 plants use the C4 carbon fixation pathway to increase their photosynthetic efficiency by reducing or eliminating photorespiration.

	• Management practices: straw is a co-product of cereal production (for human and animal consumption), so converting it into a biobased material does not increase the use of fertilisers for these crops, nor the use of plant protection products.
Hemp	• Cultivation: fast-growing crop (≈100-120 days). Planted in May, harvested in August for the flowers and textile fibre, or September for the seed and technical fibre. • Management practices: included in a rotational system between two crops (5 years between two hemp cultivations on a field). There is no need to apply fertiliser or plant protection products, and growing hemp improves yields for the following crop, thanks in particular to its deep root system, which improves soil structure.
Miscanthus	• Cultivation: Miscanthus is a perennial crop (20 years), harvested annually from the second year after planting. • Management practices: a small amount of herbicide is sometimes needed at the start of the crop for the time it takes to emerge, and from the second year onwards miscanthus no longer requires any inputs.
Flax	• Cultivation: fast-growing crop (≈100 days). Planted between March and April, harvested in July. • Management practices: included in a rotational system between two crops (4 years between two flaw cultivations on a field). This crop needs very little fertiliser and does not require the use of plant protection products.

3.2.3 Potential burden on water resources

The production of hemp, flax, and miscanthus has a number of implications related to water resources, often positive ones. These effects are related either to water efficiency or the use of fertilizers.

Hemp cultivation demonstrates greater water efficiency compared to cotton, requiring less irrigated water and having a lower water footprint per unit yield output (Wise et al., 2023; Kaur & Kander, 2023). The water needs of hemp and other crops vary based on factors like climate, soil properties, and species. While hemp is generally considered to require less water compared to cotton, the water needs of fibre flax can be relatively high, although studies have a range of outcomes in this regard. Some studies suggest that flax can exhibit improved drought tolerance (Stavropoulos et al., 2023). Similarly, the water use efficiency of miscanthus is considered to be high, and the crop demonstrates strong tolerance to drought and other stresses like heat, cold, pests, and diseases (Wang et al., 2021).

Although in general hemp is considered to require little to no chemical input during cultivation, especially as regards pesticides and herbicides (Wise et al., 2023), the use of fertilizers can lead to negative environmental impacts, such as eutrophication (Kaur & Kander, 2023; Schulte et al., 2021). Fertilizers, particularly phosphate fertilizers like Triple superphosphate, contribute significantly to eutrophication indicators by releasing phosphate ions into water bodies. Optimizing fertilizer usage while maintaining yields is crucial for reducing environmental impacts (Kaur & Kander, 2023).

3.2.4 Potential burden on land resources

In general, the cultivation of hemp, flax, and miscanthus has positive effects on soil, improving soil quality and reducing the need for fertilizers and other chemical inputs.

Both hemp and miscanthus contribute to soil stability and quality. Hemp has been utilized for bioremediation purposes, removing heavy metals from soil, and increasing soil oxygenation (Kaur & Kander 2023). Miscanthus promotes carbon deposition, improves soil physicochemical properties, and

prevents soil erosion. However, they may still have some ecological impacts, such as surface soil acidification in the case of miscanthus (Wang et al., 2021).

Hemp cultivation serves as a beneficial component in crop rotation systems, suppressing the growth of harmful organisms like certain fungi and nematodes, as well as weeds. It can be grown in monoculture for several years without significant yield decrease, making it a valuable predecessor for other key crops. However, care should be taken as over-reliance on hemp in monoculture may lead to a decrease in soil fertility (Pylypchenko et al., 2023).

Hemp cultivation typically requires minimal use of plant protection products and herbicides due to its efficient weed suppression capabilities. Additionally, hemp demonstrates low fertilizer requirements, particularly in regions where it shows little response to nitrogen fertilization (Ingrao et al., 2015; Kaur & Kander, 2023). The environmental performance of feedstock cultivation for crops like miscanthus heavily depends on fertilizer management practices. Opting for high-yielding genotypes with low nitrogen fertilizer requirements can improve environmental performance, and attention to conversion processes during cultivation is also crucial (Lask et al., 2018).

Flax cultivation requires an improved approach to fertilizer, herbicide, and pesticide management to improve its impact on soil (Le Duigou et al., 2011). Organic fertilizers offer a viable alternative, and research by Stravropoulos et al. (2023) suggests that a combination of both organic and inorganic methods may present a promising solution for maintaining soil fertility and improving overall efficiency.

3.2.5 Potential burden on biodiversity

Hemp is noted to have important benefits for biodiversity, especially compared to most other monocrops (Kaur & Kander, 2023). It is especially valuable crop for bee populations because it begins flowering when other crops have completed blooming, thus making it an excellent pollen resource (O'Brien & Arathi, 2019).

4 Screening results and recommendations

4.1 Overview – French Atlantic Arc

Resources screened		Ordinal Baseline Rating	Cultivation Management Practices	
Category	**Sub-Category**		**Potentially beneficial to the baseline status**	**Potentially detrimental to the baseline status**
Water	**Surface water bodies**		**- Carefully managed irrigation** **- Adequate fertilizer and chemical management.** **- Adequate management practices for hemp, miscanthus and flax cultivation can improve the status of water resources**	**- Excessive fertilizer use** (cereal straw)**,** especially phosphate fertilizers.
	Groundwater bodies			
Land Resources	**-**		- Conservation tillage and mulching (with care taken to not increase pesticide use). - Contouring - Avoiding planting crops on high slopes **- Adequate management practices for hemp, miscanthus and flax cultivation can improve the status of soil resources**	**- Excessive fertilizer use** (cereal straw)**,** especially phosphate fertilizers.
Biodiversity	**Endangered Species**	**18**	**- Hemp, flax and miscanthus plants, because of their height, density, low input requirements and harvesting outside bird nesting periods, are refuges for biodiversity**	**- Excessive water abstraction** can be damaging for habitats of certain threatened populations. **- Poor fertilizer management** can also damage aquatic and terrestrial habitats.
	Critically Endangered Species	**1**		

4.2 Recommendations

Surface water bodies: the screening of reported data has shown that the majority of rivers and lakes in the French Atlantic Arc (encompassing 3 RBDs) fail to achieve the objectives of the EU WFD. This raises concern for new or increased pressures that could arise from the development of new economic activities in the region or the expansion of existing operations. The ecological status of rivers and lakes in the three RBDs are of high concern, and the chemical status of moderate concern, with significant chemical and nutrient pollution across the region. Care must be taken to minimize the use of chemical inputs in the production of crops for the bioeconomy, and activities should aim to restore aquatic habitats where possible.

Groundwater bodies: The quantitative status of groundwater bodies remains of low concern in the area. However, given the impacts of climate change of water availability, care should be taken with regards to irrigation and water use. Fortunately, the crops discussed in this assessment are recognized for the high water efficiency. The chemical status of groundwater in the region is however of high concern, and as mentioned above, care should be taken to avoid discharge of chemical inputs including fertilizers, herbicides, and pesticides.

Soil: In general, soil resources in the region are in a good state. However, there is nonetheless exposure to erosion, both in coastal areas and arable areas, due to intensive farming practices. Although the general picture remains positive, there are variations at the local level, where erosion may be of high concern. In these areas, certain measures can be taken to reduce the risk of erosion including conservation tillage and mulching, contouring, and avoiding planting crops on high slopes. Any activities and practices that restore and preserve soils should be promoted.

Biodiversity: The production of the crops relevant in the French Atlantic Arc can have important benefits for biodiversity. Although there are no specific concerns related to biodiversity in the region, these crops act as a valuable resource for certain habitats and for bee populations.

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