



RESEARCH IN ENVIRONMENTAL SCIENCES

With the depletion of the planet's resources, preserving the environment has become one of the major challenges of French research and innovation. Those efforts are aimed at developing sustainable forms of growth and agriculture that will enable societies to meet their needs for food and adapt successfully to climate change. Conserving resources and raw materials, mitigating climate change, and protecting air quality are the subjects of research efforts that bring together disciplines as diverse as ecology and natural milieus, water and biodiversity, green chemistry, ecosystems, the geosciences, land-use planning, and management of natural resources and wastes, as well as ecotechnologies, alternative energy, and clean transportation.



UNDERSTANDING THE ENVIRONMENT AND CLIMATE

Multidisciplinary fields are devoted to the understanding of the physical, chemical, and biological equilibriums of the earth's environment: study of the climate; the dynamics and thermodynamics of the atmosphere and the oceans; radiative transfer, the functioning of the continental and marine biospheres; the biogeochemical and physico-chemical cycles of pollution in air, water, and soils; experimental and technical developments in remote sensing, environmental engineering, and planetology;

among many other topics. Knowledge of natural systems, the genesis of resources (mineral and energy resources; water; soil; crop production; forests), sustainable use and management of those resources; waste processing and management; food safety; environmental security; and risk management—all appear on the research and development agendas of French academic institutions, organizations, and businesses. Research in ecology and the functioning of ecosystems (the continental and marine biospheres) relies on

Research in environmental sciences draws on the life sciences and health, earth and space sciences, marine sciences, and basic disciplines such as agronomy, biology, chemistry, and physics, as well as economics, the social sciences, and management. In other words, environmental science research is characterized by interdisciplinarity.

Research topics in the environmental sciences include observation and monitoring of the earth, protection of the environment and management of environmental assets, and exploitation of the oceans and continental land masses. French research in environmental sciences is also oriented toward the transition of energy policies to "green growth."

biology—the integrative biology of plants, the dynamics and thermodynamics of the atmosphere and oceans, and on sedimentology. The integrative ecology of the systems formed by populations and their environment, the functioning of ecosystems, the dynamics of diversity as affected by human activity, the conservation of biodiversity, the ecology of coastal systems, harvested marine ecosystems (fisheries), and the space available to us for development—these, too, are subjects of environmental sciences research.



> Environment and health

Environmental physics and ecotoxicology, as well as biogeochemical cycles and the physical chemistry of air, water, and soil pollution, are among the research topics that underpin fields such as environmental toxicology and pollution control for a variety of purposes—among them adaptation to environments polluted by heavy metals, use planning in coastal zones, green chemistry and the environment, and the treatment of atmospheric pollution.

Adaptation to the climate (particularly in the tropics), cancer and the environment, the epidemiology of tropical parasites, biological methods and algorithms are examples of research conducted to determine the effects of the environment on health and safety. Natural telluric risks (volcanoes, earthquakes, landslides) are also a part of the research to study this impact on populations.

> Responsible exploitation of the seas

Water, indispensable for life and for economic development, will be a major strategic challenge for many of the world's countries in the 21st century. The major water-related sectors of the economy encompass resources, agriculture, aquatic biodiversity, health, urbanism, estuarial and coastal zones, and the treatment of soil and water pollution. Current research on water-related issues is oriented toward environmental protection: management of water, effluents, and waste; soil decontamination; measurement of water, air, and soil quality; and optimization of water treatment plants. Marine biologists concentrate on conserving and protecting marine resources and coastal environments. Water is also a form of renewable energy: geothermia is already used to supply heating systems, triggering innovations in building construction.

> Energy

New materials, innovative structures, and research into the many questions pertaining to the effect of energy production on the environment are helping to improve energy efficiency and storage related to fossil fuels, fissile materials, and, particularly, renewable energy: wind, solar (thermal, photovoltaic, and concentrated), geothermic, wave, hydroelectric, and hydrogen fuel cell, as new bioenergies that are the subject of much new research in France.

Alternative energies that assure energy efficiency using clean technologies are analyzed from the point of view of their yield and emissions. Energy efficiency is a particular focus, along with work on solar energy, energy storage, biofuels, and energy derived from the seas.

Applications for the production of low-carbon technologies have an impact on agricultural technologies and practices, transportation, and regional land planning. Within the framework of environmental initiatives for the design and construction of buildings of high environmental quality, the concept the "positive energy building" (achieved partly through advanced insulation) is a primary challenge. In the area of air transportation, aeronautical research is aimed at lowering fuel consumption, CO₂ emissions, and atmospheric pollution.

> Advanced scientific instrumentation

Basic multidisciplinary research of the highest quality creates the conditions for technological breakthroughs and success in achieving the energy transition through 2050.

That research depends on the use of the advanced scientific instruments available to scientists in France, such as spectrometers, nuclear devices (radioactive materials, accelerators, reactors), sensors, and large instruments. Research platforms are equipped for cellular imaging, in vivo imaging, and proteomics applied to the environment.

OUR ECOLOGICAL FOOTPRINT

The ecological footprint measures the impact of human activity on ecosystems and the planet as a whole by assessing the bio-productive land area required to accommodate a population's consumption of space and resources (food, heat, clothing, building materials, goods and services, housing, roads, clean air, potable water, and so on) and to absorb its waste products. At the planetary scale, humanity's ecological footprint is an estimation of the biologically productive area of land and ocean needed to meet the needs of the human race. The ecological footprint and biological capacity are two of the most critical indicators of the state of the planet's environmental capital.

THE MAJOR DISCIPLINES AND SECTORS ENGAGED IN RESEARCH IN ENVIRONMENTAL SCIENCES

- > Agronomy, agriculture, food processing, agroecology, fisheries, forestry, horticulture
- > Architecture, urbanism, regional and rural planning and land management
- > Biology (populations, organisms, ecosystems, marine environments), biodiversity, biotechnologies, genetics, genomics
- > Chemistry, geochemistry (isotopic, marine)
- > Ecology (functional, behavioral, industrial), ecotechnologies
- > Economics and management, environmental law, water resource management
- > Energy (efficiency, storage, alternatives, renewables)
- > Geography, geomatics
- > Environmental engineering, civil engineering, sanitary engineering, water management techniques
- > Physics, astrophysics, geophysics
- > Atmospheric, meteorology, climatology, paleoclimatology
- > Sea sciences, oceanography
- > Earth and space sciences, geosciences, geotechnics, planetology, astronomy, geology, glaciology, hydrology
- > Life and health sciences, public health, epidemiology, toxicology
- > Transportation, tourism

STRATEGY ON THE ENVIRONMENT SUSTAINABLE DEVELOPMENT AND CLIMATE CHANGE

In the 1990s, France began several air-quality and wastetreatment initiatives. Environmental protection became a national priority with the creation of the Agence de l'environnement et de la maîtrise de l'énergie (ADEME, environment and energy security agency) and the adoption of a national environmental plan. Under the Kyoto Protocol, France made a commitment to stabilize, over the period 2008–12, greenhouse gas emissions at 1990 levels. In 2000, the Programme de Lutte contre le Changement Climatique (PNLCC, program to combat climate change) made it possible for France to meet its commitment.

By 2004, France had made a plan, which was followed in 2007 by a national environmental task force. Programs that included renewable forms of energy were incorporated into a master carbon assessment, which gave rise to regional climate plans that by 2012 enabled France to reduce its emissions by 12%.

Within the framework of the new national environmental plan, research and innovation play a major part in France's energy transition. The goals of the plan are energy security, prudent management of resources, the protection of human and environmental health, limitation of climate risks, and social and geographic cohesion. Energy research therefore takes into account the low-carbon strategy and climate change, with a priority for programs at the European level.

■ **Alliance nationale de recherche pour l'environnement** (AllEnvi, national environmental research alliance)— food, climate, water, land use www.allenvi.fr

AllEnvi brings together public research efforts to program and coordinate France's environmental science strategy. Food and feed, animal life, biodiversity, climate, water, ecotechnologies, environmental assessment, the seas, plant life, risk, land use, cities, and mobility are current thematic priorities. On land, the consolidation of networks for the observation of flows of carbon, water, and energy between the atmosphere, the biosphere, and soils has emphasized the importance of biodiversity. Research into how opinions are formed and into the modification of behaviors involving environmental risk is making it possible to implement targeted regulations and incentives.

■ **Agence de l'environnement et de la maîtrise de l'énergie** (ADEME, environment and energy security agency) www.ademe.fr

ADEME participates in the implementation of the national sustainable development strategy and of environmental public policies. Five areas are emphasized: (i) wastes, (ii) contaminated ground and wastelands, (iii) energy and climate, (iv) air and noise pollution, and (v) cross-cutting actions (sustainable production and consumption, sustainable cities and regions). ADEME supports research and development into vehicles, buildings, new energy technologies, and ways to use alternative and renewable energy to reduce greenhouse gas emissions.

■ **Agence nationale de la sécurité sanitaire de l'alimentation, de l'environnement et du travail** (ANSES, national agency for food, environmental, and workplace safety) <https://www.anses.fr> >Santé et environnement

ANSES assesses the impacts of the environment on health and identifies safety risks linked to ambient environments (air, water, soil) or physical forces (fields and waves). It also tests pesticides and germicides before they are introduced into the market, as well as chemical products covered by the REACH program of the European Chemical Products Agency.

■ **CIRAD, agronomic research for development** www.cirad.fr >Nos recherches

CIRAD uses research as a tool for development in its areas of priority: ecologically intensive agriculture, commercial uses of biomass, sustainable food production, plant and animal health, and public action for development, societies, and natural environments. CIRAD's research themes include climate change and agriculture, biodiversity and development, the future of tropical forests, food security, subsistence agriculture and livestock tending. .





■ **GIS Climat-Environnement-Société** (scientific interest group on climate, environment, and society) www.gisclimat.fr

GIS supports and coordinates interdisciplinary research on climate change and its environmental and social effects, relying on the expertise of the research laboratories of the Île-de-France in the fields of climatology, hydrology, ecology, health, and the humanities and social sciences.

■ **Commissariat à l'énergie atomique et aux énergies alternatives** (CEA, commission on atomic and alternative energy) www.cea.fr

CEA works in four major areas: low-carbon forms of energy (nuclear and renewable), defense and security, information technologies, and health technologies.

■ **IFP Énergies nouvelles** (IFPEN, new energies) www.ifpenergiesnouvelles.fr

In its research and training activities, IFPEN covers the fields of energy, transportation, and the environment. It concentrates its research efforts on finding solutions for society's energy and climate challenges, emphasizing the development of sustainable energy. Projects are clustered into five different themes: renewable energy, eco-responsible production, innovative transportation, eco-efficient processes, and sustainable resources.

■ **Institut français de recherche pour l'exploitation de la mer** (IFREMER, French Research Institute for Exploitation of the Sea) <http://wwwz.ifremer.fr>

IFREMER is a marine research institution whose research fields include undersea technologies, biodiversity, fisheries and aquaculture, coastal environments, mineral resources, biotechnologies, and operational oceanography, among others.

IFREMER is organized into several scientific departments (biological and environmental resources; physical resources and undersea ecosystems; oceanography and ecosystem dynamics; digital and marine infrastructure) that operate in five multi-site centers: Atlantic, Brittany, North Sea–Channel, Mediterranean, and Pacific.

■ **Institut national de recherche en sciences et technologies pour l'environnement et l'agriculture** (IRSTEA, national institute of environmental and agricultural sciences and technology) www.irstea.fr

Having earned the Institut Carnot label, IRSTEA cooperates with other research organizations (CIRAD, CNRS, INRIA) and academic research clusters in pursuit of public policy goals. IRSTEA is also involved in European environmental research networks (EurAqua, PEER), as well as numerous exchanges and cooperative agreements with research institutions around the world (Australia, Brazil, Canada). With nine regional centers, IRSTEA is organized into three scientific departments: (i) Water, (ii) Ecotechnology, and (iii) Regions. About 30 percent of its research effort is related to global issues, including climate change; 70 percent relates to surface-water issues.

■ **Institut national des sciences de l'Univers** (INSU, national institute of space sciences), CNRS www.insu.cnrs.fr/environnement

INSU, a part of CNRS (France's national center for scientific research), carries out research in astronomy and in the earth, space, and marine sciences. It organizes and supports environmental research, providing resources for laboratories. Meteorology and climate, as well as air, water, and soil quality and composition, are studied in cooperation with the Observatoire des Sciences de l'Univers (space sciences observatory).



■ **Météo-France – Centre National de Recherches Météorologiques** (CNRM-GAME) www.cnrm.meteo.fr

The National Center for Meteorological Research (CNRM-GAME) of the French national weather service is operated jointly with CNRS. It undertakes research involving observations of oceanic, atmospheric, and snow-covered environments, digital forecasting of weather and climate simulations, water cycles, exchanges between ocean and atmosphere, atmospheric physical chemistry, urban meteorology, comparison and modeling for digital weather forecasting, instrument development, and snow covers.

■ **Observatoire national sur les effets du réchauffement climatique** (ONERC, national observatory on the effects of global warming)

www.developpementdurable.gouv.fr/-Impacts-et-adaptation-ONERC.html

ONERC collects and disseminates information on risks linked to climate change. It also formulates recommendations concerning adaptive measures to limit the impacts of climate change using indicators and the expertise of the IPCC in France.



USEFUL LINKS

- **ANCRE**, the national coordinating alliance for energy research: www.allianceenergie.fr
- **Bilan GES**, resource center on greenhouse gas assessments: www.bilans-ges.ademe.fr
- **CEREGE**, European center for research and teaching in geosciences and environment: <https://www.cerege.fr>
- **CNRM**, national center for meteorological research: www.cnrm.meteo.fr
- **Conservatoire du littoral** (coastal conservatory): www.conservatoire-du-littoral.fr
- **2015 Paris Climate Conference**: www.diplomatie.gouv.fr >Politique étrangère de la France>Environnement et développement durable
- **École Nationale de la Météorologie** - INP Toulouse-ENM Météo France: www.enm.meteo.fr
- **Energy and climate research challenges**: [www.cea.fr/Energies/Impact sur le climat](http://www cea.fr/Energies/Impact sur le climat)
- **FIRE**, Ile de France federation for environmental research: www.upmc.fr >Recherche>Terre vivante et environnement>Structures fédératives
- **France's water authorities**: www.lesagencesdeleau.fr
- **Geoïdd interactive map** (France and coastlines), observation service, and statistics from the Ministry of Ecology, Sustainable Development, and Energy: www.statistiques.developpement-durable.gouv.fr/cartographie/750.html
- **Le Guide des bonnes pratiques en matière de développement durable dans les universités françaises** (guide to good sustainable development practices in French universities): www.cpu.fr >La CPU>Publications>Mot-clé> Développement durable
- **INSU**, national institute of space sciences: www.insu.cnrs.fr
- **IRSN**, institute on radioactivity and nuclear safety: www.irsu.fr
- **OMP**, Midi-Pyrénées observatories: www.obs-mip.fr
- **ONCFS**, national hunting and wildlife service: www.oncfs.gouv.fr
- **ONEMA**, national office on water and aquatic milieus: www.onema.fr
- **ONERC**, national observatory on the effects of global warming: www.developpement-durable.gouv.fr/-Impactset-adaptation-ONERC-.html
- **ONF**, national forestry service: www.onf.fr
- **RAC-FR**, network for climate action, France: www.rac-f.org
- **SAFIRE**, research aircraft: www.safire.fr
- **Sagascience**, a collection of multimedia files from CNRS on climate issues and topics: www.cnrs.fr/cw/dossiers/saga.htm
- **Scientific interest** group on climate, environment, and society: www.gisclimat.fr
- **UNFCCC**, United Nations Framework Convention on Climate Change: <https://unfccc.int>
- **UVED**, virtual university of the environment and sustainable development: www.uved.fr



www.horizon2020.gouv.fr



<http://eit.europa.eu>

The European "Climate Action, Environment, Resource Efficiency, and Raw Materials" challenge

For the period 2014–2020, the European Union's program of financing for research and innovation (€79 billion) has three priorities: scientific excellence, manufacturing competitiveness, and social challenges. Challenge number 5 of Horizon 2020, the European research and innovation program, is "Climate Action, Environment, Resource Efficiency, and Raw Materials." The goal of the challenge is to reconcile global population growth with the planet's limits in terms of natural resources and ecosystem balance. The challenge program supports the production of new knowledge and the development of tools, methods, policies, and eco-innovations. Activities related to climate, environment, and resources figure in requests for proposals for the Blue Growth program: exploiting the potential of the oceans (bioeconomy challenge), energy efficiency (energy challenge), and "disaster resilience: protecting and safeguarding society," including in its adaptation to climate change (security challenge).

FRENCH RESEARCH PORTAL

WWW.CAMPUSFRANCE.ORG/EN/RESEARCHER

A UNIQUE, **ONLINE-ACCESS INFORMATION POINT**
FOR LOCATING RESEARCH PROJECTS



◆ UNDERSTANDING FRENCH RESEARCH

- > Understanding how PhDs operate in France;
- > Knowing how to start and finance a PhD;
- > Applying to international research programs (Hubert Curien Partnerships, *Make Our Planet Great Again*).



◆ DIRECTORY OF DOCTORAL INSTITUTIONS

Point of entry for starting a PhD and the 270 doctoral institutes organizing and supervising doctoral training.

- > Search by key words, regions, and disciplines;
- > Comprehensive information on doctoral institutions: Research areas, criteria and points of contacts for admission, welcome mechanisms, proposed topics, current financing, international dimension, and points of contacts for associated research laboratories;
- > Access to fields offered by each doctoral institutions.

49 doctoral schools dealing with the environment domain, accessible at

<https://doctorat.campusfrance.org>



◆ PhD TOPICS, LABORATORY INTERNSHIPS, AND POST-DOCTORAL STUDIES:

- > Offers financed through doctoral contracts, Industrial agreements for training through research (CIFRE), and specific offers devoted to programs financed by foreign governments;
- > Offers for internships for experience in laboratory research;
- > Post-doctoral offers for work in French laboratories;
- > A detailed financing mechanism for each research offer (PhD topics, post-docs, and internships);

Almost 150 offers made public in environment each year, accessible at:

<https://doctorat.campusfrance.org/phd/offers>