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FOREWORD

Environment and climate change are nowadays of major concern for European citizens. Every day Europeans hear about global warming, melting of ice, health problems related to environmental degradation, sustainable transportation, pollution in costal areas, and so on. Environmental awareness among European citizens is taking shape but it needs to be improved.

European research in the field of environment (including climate change) has a very rich history and achievements, and will continue to play an important role in the years to come. To build an environmentally sustainable economy Europe needs to invest more in knowledge and innovation. Environmental research has three overarching goals to comply with these challenges: to determine the environmental tipping points and trends, to assess the impacts of environmental change and, above all, to develop a capacity to respond by providing new knowledge, technologies and strategies for the sustainability of our planet, and for the wellbeing of European citizens.

Through successive European Research Framework Programmes, European researchers contribute to finding solutions to environmental issues. This is sought via strategic partnerships, which will allow to build a European Research Area (ERA) and a knowledge- society based on education, research and innovation. However, as environmental problems have no borders and require a global approach, European research is also promoting important cooperation with third countries, such as USA, China, Russia, India, Brazil, as well as with the Mediterranean, African and Latin American regions.

This brochure summaries environmental research funded by the European Union and is divided in two parts. The first provides the context of environmental research – the historical roots and the political framework as well as an introduction to environmental research in the Seventh Framework Programme (FP7), under the theme “Environment (including climate change)”, an ambitious research programme. The second part gives an overview of the ten research priorities within the “Environment (including climate change)” research theme, and highlights some of the most successful projects in environmental research.

I sincerely hope that this comprehensive overview of European environmental research will help convey the main challenges and goals we are facing and to raise awareness of the value of environmental research in our everyday life for the sustainability of our planet.

Manuela Soares,
Director for Environment (including climate change) Research

History of EC environmental research

Europe has a distinguished history of environmental research and hosts many of the world's leading researchers in the environmental field. Environmental concerns have also been on the policy agenda since the European Union was created in 1957. The International Geophysical Year (IGY) was launched in the same year, the first attempt to coordinate global measurements of the Earth, the oceans, the atmosphere and the sun. It also pointed out for the first time that carbon dioxide was building up in the atmosphere. The decades since then have witnessed increasing public concern about our environment and the damage being done to it, alongside greater research efforts to increase knowledge and find solutions.

The first environmental directive of the European Economic Community (EEC) was passed in 1967[1], covering the classification, packaging and labelling of dangerous substances, followed by a first attempt to address the impact of vehicle emissions on air pollution three years later. But it was in 1973 that the first "European Environment Action Programme" was launched, along with the "Protection of the Environment Programme". In the same year, the Environment and Consumer Protection Directorate was established, the precursor to the current DG Environment (DG ENV) and DG Health and Consumer Protection (DG SANCO).

The environmental action programmes continued into the 1980s, and in 1981 the creation of the DG for Environment, Nuclear Safety and Civil Protection coincided with the launch of the Environmental Protection and Climatology research programme. But it was with the introduction of the First Framework Programme (FP1) in 1984 that EU research for the environment as we know it began to take shape.

1 See http://eur-lex.europa.eu/smartapi/cgi/sga_doc?smartapi!celexplus!prod!DocNumber&lg=en&type_doc=Directive&an_doc=1967&nu_doc=548.

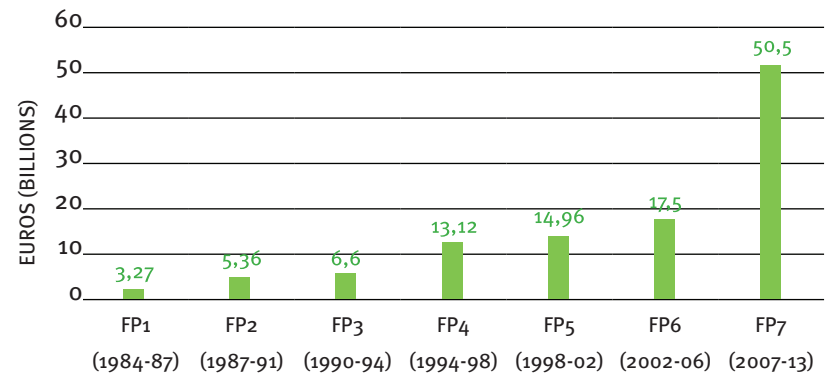
Framework programmes

The Framework Programmes for Research and Technological Development, called Framework Programmes (FP) for short, are funding programmes created by the European Union to support European research. The first FP was launched in 1984 and since then they have increased in both size and ambition.

From the start, the purpose of the Framework Programmes has been to encourage transnational collaborative research projects – an essential requirement for all EU-funded projects has been that research teams come from more than one EU Member State. Over time this has developed into the strategic goal of creating a European Research Area that allows for the integration of the EU's scientific efforts. Further afield, the Framework Programmes have also been instrumental in encouraging research cooperation with international partners across the globe.

Each Framework Programme has had different specific objectives and actions, but there has been a trend since the 1980s away from hard scientific and technological research towards multidisciplinary research focused on social demands. At the same time, the Framework Programmes aim to address the problem of fragmentation at the European level and the increasing complexity and costs of high-level research – which few Member States have the resources to address and undertake alone.

Budget of the EU Framework programmes



EUROPEAN RESEARCH: THE "ADDED VALUE"

FP1 introduced the concept of coordinated European Community research within an established timeframe and structure. The guiding principle was (and remains) to support research which benefits from the "added value" of being conducted at the European level, a principle that has gradually evolved into the concept of the European Research Area (ERA)[2].

Environmental issues have been a part of the Framework Programmes from the beginning. However, whereas the primary focus of FP1 was technological and on energy (which captured 49 per cent of the budget),

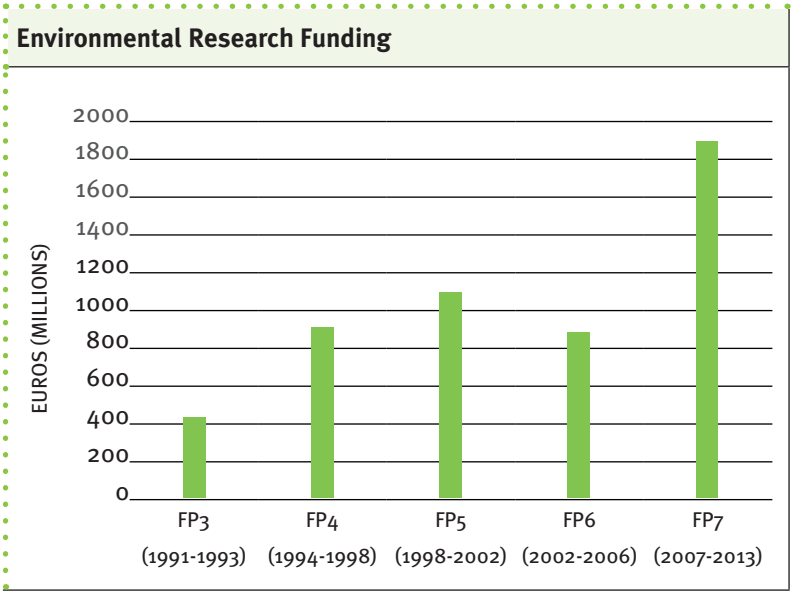
2 See http://ec.europa.eu/research/era/index_en.html for more information about the European Research Area.

subsequent Framework Programmes began to incorporate a more multidisciplinary "systems approach" and focus on Europe's economic and social needs, including environmental protection. Environmental research was an obvious beneficiary: problems like polluted waterways or acid rain do not respect national boundaries so need to be tackled in a coordinated way. The need for cross-country collaboration paved the way for environmental R&D becoming a research priority of the Framework Programmes.

Early examples of environmental research collaboration are the European Arctic Stratosphere Ozone Experiment (EASOE)[3], which started in 1989 in response to concerns about the ozone layer (and as part of the EU's commitment to the 1987 Montreal Protocol), and the ECHIVAL Field Experiment in a Desertification Threatened Area (EFEDA) project[4], launched in 1990, which sought to bring an integrated response to water shortage in semi-arid regions.

INCREASING IMPORTANCE OF RESEARCH

Expanding environmental awareness in Europe was reflected in the growing funds allocated to environmental research. By the time FP3 was launched in 1991, environmental research and marine sciences already had a budget of 410 million ecus (or euros – the conversion rate was one to one). FP4 (1994-98) research in the environment and climate had a budget of 914 million ecus / euros (with a further 243 million dedicated to marine sciences and technologies, or MAST). FP5 (1998-2002) saw the budget rise to €2.1 billion in the programme "Energy, Environment and Sustainable development" with €1.1 billion dedicated to the "Environment and Sustainable Development" sub-programme. FP6's "Sustainable Development, Global Change and Ecosystems" programme had a total budget of €2.3 billion (of which €853 million supported 280 projects in the "Global Change and Ecosystems" sub-programme). The "Environment (including climate change)" theme of FP7 (2007-13) was allocated a budget of €1.9 million.



3 See http://ec.europa.eu/research/success/en/env/0068e.html for more information about the EASOE project and another ozone-measuring project called SESAME.

4 ECHIVAL itself stands for "European International Project on Climatic and Hydrological Interactions between Vegetation, Atmosphere and Land Surface". See http://cordis.europa.eu/eesd/src/mtr_shortage.htm for more information on the EFEDA project.

MAJOR RESULTS FROM FP5 AND FP6

Environmental research progressed notably in the Fifth and Sixth Framework Programmes – FP5, running from 1998-2002, and FP6, from 2002 to 2006. At a time when the idea of a European Research Area first began to surface, the Framework Programmes reinforced the strength of environmental research within Europe and with its research partners. Reflecting this, FP-funded environmental research achieved a number of results in this period.

FP5-funded research within the "Environment and Sustainable Development Programme" focused on four key actions which followed a problem-solving approach:

1. Sustainable management and quality of water;
2. Global change, climate and biodiversity;
3. Sustainable marine ecosystems;
4. The city of tomorrow and cultural heritage.

In addition research and technological development was conducted in the fields of natural hazard research, earth observation, and the socio-economic aspects of environmental change and sustainable development. Research infrastructures were also created and reinforced, in particular in the areas of climate and global change, marine, and natural hazards research. Notable research successes were in marine research, especially the development of integrated management tools for European seas and coastal regions.

FP6 built on the work of FP5, with a total of 280 projects supported by EU funds in the "Global Change and Ecosystems" programme. The thematic coverage grew to ten areas, the most important of which in terms of budgetary allocation were: research into the impact and mechanisms of greenhouse gas (21.4 per cent of the total), the water cycle (19.9 per cent), and biodiversity (17.3 per cent).

Notable in FP6's structure was the growing space given to international cooperation and SME support, reflecting on the one hand the need for more research cooperation with third countries, and on the other the need to strengthen the links between scientists and industry. The need to support policymakers was also recognised, and a new research tool tailored specifically for the purpose was created across the FP, the "Scientific Support to Policies" projects (see below). Major research was undertaken in the polar regions, including climate change research in the Arctic, while mitigation strategies were developed in the urban, marine, and soil areas.

Research: the building blocks of policy

The environment is an important political issue in Europe. This is the region where Green parties first found political footing and where waste recycling first became standard practice. Member States have also committed themselves to a number of national and international environmental conventions: from the use of pesticides to the trade in endangered species, from urban air quality to the Kyoto Protocol[5], the EU is dedicated to environmental political action.

Environmental concerns and the public demand for policies that support the environment are likely to grow even further in coming years. Public concerns about environmental degradation and unsustainable development, the greater visibility of environmental disasters around the world and preoccupations about the future have created a powerful stimulus for politicians to act.

Climate change is a case in point. There is now political consensus that climate change is a fact and that action must be taken. This consensus was notably achieved following the release of the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) in 2007. The report presents findings that show most of the observed increase in global average temperatures since the mid-20th century is *very likely* due to the observed increase in anthropogenic greenhouse gas concentrations. In addition, discernible human influences now extend to other aspects of climate, including ocean warming, continental average temperatures, temperature extremes and wind patters. The credibility of the IPCC, in which many leading European climate scientists are involved, lends weight to the argument that climate change is a problem that needs to be tackled urgently.

For new policies to be effective and to be accepted by society, they need to have a strong rationale, especially through scientific evidence. Scientific research also offers the prospect of providing solutions to environmental problems. Environmental research is thus given the twin tasks of both raising awareness and providing solutions. It is through this increased knowledge that more accurate predictions can be made about the future and concrete steps proposed to avoid the worst climate change scenarios from taking place.

THE SUSTAINABLE DEVELOPMENT STRATEGY

Sustainable development is a core objective of the European Union: we need to ensure that our present socio-economic development does not compromise our future. Current EU policies are based on the renewed Sustainable Development Strategy (SDS) of June 2006, where research and development plays an important and multifaceted role. [6]

5 The protocol is part of the United Nations Framework Convention on Climate Change. See http://ec.europa.eu/environment/climat/kyoto.htm for more information.

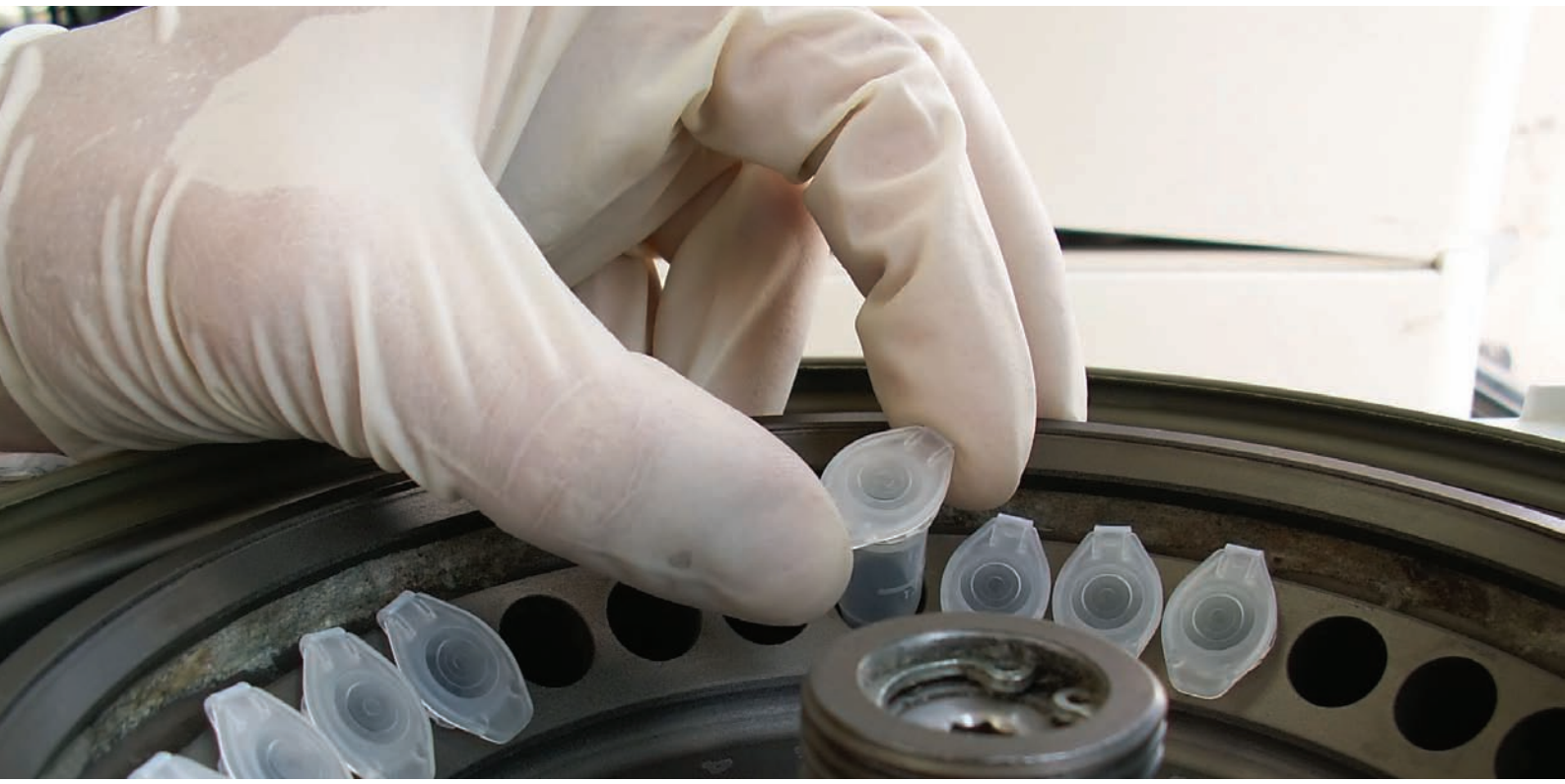
6 See http://ec.europa.eu/sustainable/sds2001/index_en.htm for details about the 2001 SDS, and http://register.consilium.europa.eu/pdf/en/06/st10/st10117.en06.pdf for the renewed strategy document.

The renewed strategy identifies seven key challenges:

1. Climate change and clean energy
2. Sustainable transport
3. Sustainable consumption and production
4. Better management of natural resources
5. Public health
6. Social inclusion
7. Global poverty.

Multi-faceted by nature, incorporating environmental, economic and social concerns, sustainable development is tackled in a similarly multi-faceted way in the Seventh Framework Programme (FP7).[7] The FP7's integrated approach identifies the need for cross-cutting thematic contributions, concepts and improved measuring tools.

The Cooperation Programme, the largest part of FP7 (with around 60 per cent of the budget) has ten themes, each of which calls for sustainable development-related research. These focus for example on enhancing energy and resource efficiency, increasing the quality of the monitoring and management of natural resources and on boosting the development of smart technologies leading to sustainable production and consumption. New short- and long-term visionary concepts will be called for in order to break the link between economic prosperity and environmental degradation. Finally, in terms of monitoring sustainable development, improved indicators and impact assessments will be developed.



7 See http://eur-lex.europa.eu/LexUriServ/site/en/oj/2006/l_412/l_41220061230en00010041.pdf for a full transcript of the decision.

As illustrated in the table below, each of the key challenges identified by the renewed SDS is addressed in the FP7 Cooperation Programme.

Cooperation Programme Theme / SDS Key Objectives	Health	Food	ICT	Nano	Energy	Environment	Transport	Socio-eco.	Space	Security
1. Climate change and clean energy		x	x	x	x	x	x	x	x	
2. Sustainable transport			x	x	x		x	x	x	x
3. Sustainable consumption and production		x	x	x	x	x	x	x		x
4. Better mgt of nat.resources	x	x	X		x	x	x	x	x	
5. Public health	x	x	x	x		x	x	x	x	x
6. Soc. incl., demography and migration	x		x				x	x		
7. Fighting global poverty	x	x						x	x	

FROM SCIENCE TO POLICY: STRENGTHENING THE LINK

The importance of scientific research for policymakers is now well-established. However the risk remains that the research proves little relevant to policymakers, or even that significant scientific conclusions fail to reach the attention of policymakers. The European Commission, aware of this potential problem, have introduced new instruments to strengthen the link between science and policy.

One such instrument, introduced in FP6, was called Scientific Support to Policies (SSP). The overall objective was to support European Community policies by providing demand-driven scientific contributions targeting specific policy needs. While policy-driven research is nothing new, the SSP structure formalised the mechanism and made it explicit. In particular, it has broadened the field of policies supported by research and has strengthened the links between science and policy. Environmental research has fed into policies developed not only at DG Environment (notably the 6th Environmental Action Plan[8]), but also at DG Fisheries and Maritime Affairs, DG Education and Cultural Affairs, and DG Health and Consumer Protection.

Environmental research in FP6 was particularly geared towards informing policymakers. Policy-focused research priorities in the "Global Change and Ecosystems" thematic area included: **"**Environmental Assessment (soil, water, air, noise, including the effects of chemical substances)**"; "**Environmental Technologies for support

8 See http://eur-lex.europa.eu/LexUriServ/site/en/oj/2002/l_242/l_24220020910en00010015.pdf. The Plan is under review, and the Commission's communication can be found at: http://eur-lex.europa.eu/LexUriServ/site/en/oj/2002/l_242/l_24220020910en00010015.pdf.

of policy decisions, in particular concerning effective but low-cost technologies in the context of fulfilling environmental legislation"; "Forecasting and developing innovative policies for sustainability in the medium and long term"; and "The protection of cultural heritage and associated conservation strategies".

FP7 continues where FP6 left off, addressing in a integrated manner those areas that require urgent policy action, filling the knowledge gaps revealed by previous research (for example, the need to better understand the influence of ocean movements on climate), and addressing emerging issues. The research supports EU-level policies, thematic strategies, programmes and directives, as well as needs arising from the implementation of international commitments at the EU-level. All of the four activities in the "Environment (including climate change)" theme include projects that are geared towards policy support.

Within the first calls for proposals for FP7, the "policy relevant and emerging needs"-related topics include for example the following:

- Climate change impacts and adaptation strategies in water policies
- Full costs of climate change
- Impacts and feed-backs of climate policies on land use and ecosystems in Europe
- European network on human biomonitoring
- Geographical Information Systems in support for environment and health research
- Investigating Europe's risk from droughts
- Assessing the ecological status of water bodies
- Development and improvement of technologies for data collection in (digital) soil mapping
- Development of technologies and tools for soil contamination assessment and site characterisation, towards sustainable remediation
- Development of integrated waste management technologies for maximising material and energy recovery/recycling of the organic (humid) fraction of municipal solid waste
- Networking and preparatory action in view of control of mercury in industrial processes and products
- Low resource consumption buildings and infrastructure
- Performance indicators for health, comfort and safety of the indoor built environment
- In-silico techniques for hazard-, safety-, and environmental risk assessment

The next section focuses on environmental research in FP7, explaining the main aims that are to be addressed and introducing the many new elements that are being brought in.

Spotlight on water security

European water is under pressure. According to European Commission statistics, one-fifth of surface water is threatened by pollution, almost two-thirds of drinking water is overexploited and half of the wetlands are endangered.

Water-related environmental research has been carried out for many years through the Framework Programmes. The RIANA system, for example, was developed in the 1990s to rapidly detect dangerous substances in rivers. Water-based research continues today with around half of the first calls for proposals in FP7 devoted directly or indirectly to water.

This research feeds into EU policies. Europe has taken the quality of its water resources seriously for some time, with the first directives introduced in the 1970s. European water policy underwent a thorough review in the 1990s, leading to the adoption of the Water Framework Directive (WFD)[1] in 2000. This streamlines the large body of legislation (on sewage treatment, drinking water, pollution, etc) into one over-arching strategy. The WFD also demands a global approach, based on river basins rather than national boundaries. In that way downstream users do not have to pay for upstream polluters.

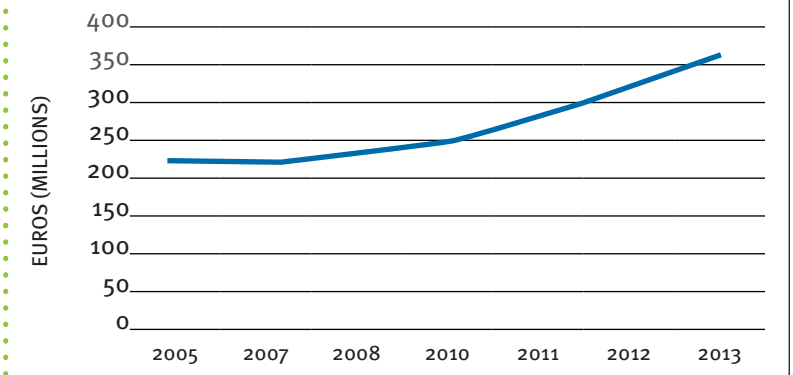
The main aims of the WFD are to: expand the scope of water protection; achieve "good status" for all waters by 2015; base water management on a river basins approach; use a combined approach of emission limits and quality standards; get prices right; involve citizens; streamline legislation. With a timeframe running to 2027, the WFD is set to transform the quality of our water resources and the way we use them.

1 http://eur-lex.europa.eu/LexUriServ/site/en/oj/2000/l_327/l_32720001222en00010072.pdf.

Environmental research in FP7

The main component of the Seventh Framework Programme (running over seven years between 2007 and 2013) is the €32.4 billion "Cooperation" programme (around three-fifths of the total), which is divided into ten research themes. Theme six is called "Environment (including climate change)": with a total budget of €1.9 billion, it will be the cornerstone of environmental research in Europe.

Indicative Breakdown - FP7 budget for environmental research



STRATEGIC VISION

The Seventh Framework Programme opens up a number of possibilities for environmental research in Europe and beyond. The budget allocated to environmental research has more than doubled in comparison to FP6 (the EU budget contribution has increased from €852 million in FP6 to a projected €1.9 billion in FP7), and this is reflected in more projects, resources and, ultimately, ambition.

Environmental research in FP7 has multiple strategic goals which aim to raise our knowledge about the environment and propose policy and technological solutions to deal with environmental problems facing Europe and the world, like the loss of biodiversity and the melting of the Arctic icecap. Research for the environment is multifaceted and interdisciplinary, and while this brings many challenges it also offers wide scope for increasing knowledge and providing solutions.

CONSTRUCTING AN ENVIRONMENTAL EUROPEAN RESEARCH AREA

The broad strategic goal is to further the integration of environmental research across the region. One of the underlying motivations behind the Framework Programmes has been the creation of the European Research Area (ERA) – an ambitious attempt to leverage greater and faster results from the combined research resources of the EU through improved coordination. This means joint research projects that cross national borders (as supported by the Framework Programmes), greater coordination between national research programmes (as encouraged in the ERA-NET scheme[9]) and greater researcher mobility (as encouraged by ERA-MORE[10]).

9 See http://ec.europa.eu/research/fp6/index_en.cfm?p=9_eranet.

10 The European Researcher's Mobility portal can be found at: http://ec.europa.eu/eracareers/index_en.cfm.

Environmental research benefits from this. There is less chance for duplication in research – instead research topics that would normally be beyond the scope of national institutions or programmes can be tackled jointly. A good example of this is research in marine biodiversity: most information to date has been fragmented and local, yet EU-funded research has allowed scientists from across Europe to come together and build a profile of marine biodiversity across the continent.

GREENING THE ECONOMY

In order for the European Union to meet its environmental commitments, it is necessary to move onto a more sustainable growth trajectory. That means using consumption and production systems that have a low environmental impact while providing new economic opportunities, growth and employment. Research into environmental technologies, one of the four main activities of the "Environment (including climate change)" theme, is at the forefront of this drive.

Technologies that improve integrated water management, that improve waste treatment or which phase out animal testing – these are just some examples of environmental technologies being investigated in FP7. Through the introduction of such technologies, we shall be able to reduce the negative impact of human activities on the environment and manage resources more efficiently. It also means greening the economy, which will allow Europe to move into a state where economic growth is no longer synonymous with resource depletion.

A GLOBAL PARTNERSHIP

International cooperation is an integral feature of the Framework Programmes. It ranges from increased researcher mobility[11] to large scale international collaboration efforts like the ITER nuclear fusion project[12]. It is growing in scale, as the benefits of greater collaboration become apparent – there are now more than 100 countries involved in EU research programmes. Environmental research is a particularly good example of this, since many environmental challenges, like desertification, do not follow national and regional borders and are replicated across the world. By combining research teams from across the world specialised in desertification new data and scientific solutions can more easily be found.

Environmental research sponsored by the EU already has a good track record in international cooperation. The "Global Change and Ecosystems" programme was the thematic programme with the most third country research participation in FP6. It allocated more than €37 million, or 4.6 per cent of the total budget to fund third country participants in European research teams. A good example of successful international cooperation in the "Global Change and Ecosystems" programme is the ALARM project[13], focused on biodiversity, which brought together 200 scientists working in 67 institutions from 35 countries around the world, including 17 non-EU countries.

International cooperation in research is often anchored in institutional agreements between the EU and third countries. Some nearby countries like Switzerland and Turkey are associated and contribute individually to the FP and benefit as full members of the European Research Area (ERA) and can participate in EU research

11 The ERA-MORE researcher's mobility portal is encouraging this (http://ec.europa.eu/eracareers/index_en.cfm), as is the People programme within FP7 (http://cordis.europa.eu/fp7/people/home_en.html).

12 http://www.iter.org/.

13 http://www.alarmproject.net/alarm/.

projects like any EU member state. Researchers and institutions in the developing world also participate and can receive budgetary support to assist them. Finally an increasing number of science and technology (S&T) agreements have been made between the European Union and third countries like China, Japan and the USA, ensuring closer research collaboration and mutual benefits[14].

The main novelty in FP7 compared to previous programmes is that international cooperation has been mainstreamed, with any third country researcher or institution being able to participate in FP7 calls. In addition, there are projects dedicated specifically to international cooperation (with a geographical focus in the developing world for example). These are called Specific International Cooperation Actions (SICAs), and they accounted for around one-sixth of first round calls in 2007, including research into the health impacts of drought and desertification and into river basin twinning initiatives as a tool to implement EU water initiatives.

RAISING AWARENESS

Most environmental threats are discreet and long-term by nature. The loss of biodiversity has been occurring for centuries. Environmental risks to our health often take many decades to build up. For that reason, it is crucial that public awareness of these issues is maintained, if only to put environmental issues on the political agenda and encourage policymakers to act. The need to keep environmental concerns on the political agenda is therefore an important implicit aim of FP7, as it was for preceding Framework Programmes.

Evidence from research is one of the most important tools for this. A good example of this is climate change. The debate surrounding climate change has raged since the 1970s, and it is overwhelming scientific evidence that has slowly undermined the arguments of doubters and helped to achieve consensus on the issue. The link between greenhouse gases and global warming, and the large body of evidence that these greenhouse gases are primarily man-made, has raised public concern and put such initiatives as carbon trading and clean technologies on the policy agenda.

EU-funded environmental research continues to provide insights into what is happening to our environment, in Europe and further afield. This greater knowledge of the intricate processes underway allows policymakers to devise legislation that allows our societies to adapt to and mitigate the most harmful effects.

NOVELTIES OF FP7

FP7 shows close continuity with preceding Framework Programmes in furthering trans-national research, for example. It is also reinforcing initiatives that were successfully introduced in previous years, like the ERA-NET scheme. At the same time, there are a number of novelties that have been introduced in FP7. One major novelty is the creation of the European Research Council (ERC), which will effectively work as a national research council at the European level. The ERC has been established to encourage groundbreaking science proposed by leading researchers themselves[15]. The ERC will also take more responsibility for project implementation.

A more obvious difference with the previous Framework Programmes is the sheer size of the total FP7 budget, triple the size of FP6. This increases the scope of research and supports the EU objective of reaching R&D spending that is 3 per cent of GDP by 2010. The structure of FP7 is also larger and more integrated, with the

14 See http://ec.europa.eu/research/iscp/index.cfm?lg=en&pg=countries for a complete list of these agreements.

15 See http://erc.europa.eu/.

breakdown into four major areas – “Cooperation, “People”, “Ideas”, and “Capacities” (with a fifth, Euratom, dedicated to nuclear research). The main area, “Cooperation”, is also specifically dedicated to the major research subjects of European research.

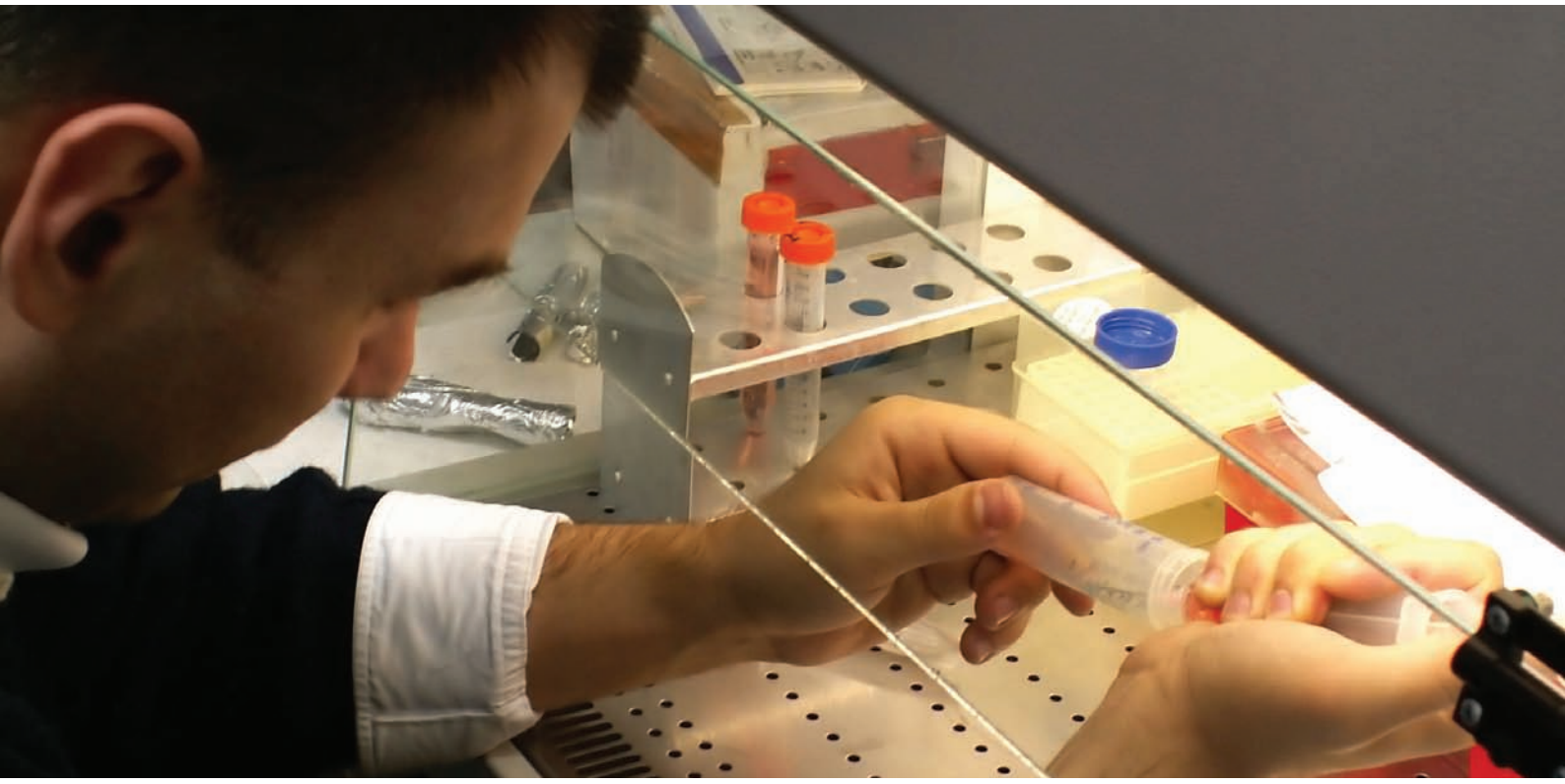
Finally the length of the Framework Programme has been extended, from five to seven years. This is in acknowledgement of the typical life cycle of research projects, and the time needed for good research to be successfully planned and concluded.

Within the environmental research theme, there is also evidence of both novelty and continuity with previous Framework Programmes. For example, new activities are to be supported in the fields of environment and health, environmental technologies, sustainable development and earth observation. Sustainable development has been mainstreamed as a component and objective of all European research (not just environmental). Above all, environmental research in FP7 is building on the successes of previous environmental research, with the following research themes the main fields in which the research will be conducted.

RESEARCH AREAS

Directorate I in the Research Directorate General is in charge of implementing and overseeing the environmental research programme, which is composed of four main research activities

Climate Change, Pollution and Risks: As the title of the overall research theme suggests, climate change is a major focus of environmental research in FP7, a reflection of growing public and political concern. This research activity has three interlinked components (called sub-activities): “Pressures on environment and



climate" (with six research areas), "Environment and health" (three research areas), and "Natural hazards" (four research areas). The focus will be on developing effective adaptation and mitigation strategies.

Sustainable Management of Resources: This activity encompasses two sub-activities: "Conservation and sustainable management of natural and man-made resources and biodiversity" (six research areas), and "Management of marine environments" (one research area). The focus will be on improving the knowledge base about natural resources and developing ideas for their sustainable management.

Environmental Technologies: As the name suggests, this activity is concerned with the development of applications that offer better protection to the environment than current alternatives. It is divided into three sub-activities: "Environmental technologies for observation, simulation, prevention, mitigation, adaptation, remediation and restoration of the natural and man-made environment" (six research areas), "Protection, Conservation and Enhancement of Cultural Heritage, including Human Habitat" (four research areas), and "Technology Assessment, Verification and Testing" (three research areas).

Earth Observation and Assessment Tools for Sustainable Development: This activity has two major components: the development and integration of the Global Earth Observation System of Systems (GEOSS) (for which there are four related research areas); and the development of forecasting methods and assessment tools for sustainable development (three research areas).

Cross-cutting issues such as dissemination activities, communication actions, management of networks of national contact points (NCPs) and coordination of international cooperation are also addressed in order to improve the visibility of the ERA.

More about the specific research areas can be found in the second part of this brochure. They have been organised into ten research fields of the "Environment (including climate change)" theme.

TECHNOLOGY PLATFORMS AND JOINT TECHNOLOGY INITIATIVES

By the start of 2007, thirty-one European Technology Platforms (ETPs) had been set up. The aim: bringing together stakeholders, under industrial leadership, to define and implement a Strategic Research Agenda (SRA) of research and technological progress in the medium- and long-term. The ETPs are an important tool for defining future research priorities.

Of the thirty-one ETPs, twelve have a "sustainable development" element, and four have a specific link to environmental research – including the Food for Life, the Sustainable Chemistry and the Water Supply and Sanitation Technology Platform.

FP7 aims to strengthen the ETPs and go beyond through the creation of Joint Technology Initiatives (JTIs): public-private partnerships which will have the task of implementing ETP SRAs. Six areas have so far been identified for JTIs, including Global Monitoring for Environment and Security (GMES), and Fuel Cells and Hydrogen.

COORDINATING NATIONAL PROGRAMMES

One of the novelties of FP6 was the creation of ERA-NETs, set up to encourage collaboration and, eventually, integration between national and regional research programmes in similar fields. The idea is that bottom-up collaboration between national research funding agencies will help further the cause of the European Research Area. At the simplest level this means the exchange of best practice and research, and the coordination of respective national programmes to avoid unnecessary duplication. At the most ambitious level this means the launching of joint programming and calls and the integration of each others' research budgets into a common pot.

Fifteen environmental ERA-NETs were formed in FP6. Environmental ERA-NETS will be further developed under FP7, including in new areas such as Environment & Health and Cultural heritage.

Furthermore, FP7 offers the possibility to ERA-Nets to upgrade to ERA-NET Plus, where the Commission offers to top up to a third of joint research projects in a joint call. The ultimate aim is full programme integration across countries. This might lead to an "Article 169" initiative that allows for financial participation by the European Community in research programmes undertaken by several Member States[16].

16 Article 169 of the EC Treaty allows for Community support in research projects, through financial participation and closer coordination. As it requires high-level authorisation (from both the European Parliament and Council) it is usually reserved for major projects – the first one, on "European and Developing Countries Clinical Trials Partnership" (EDCTP) was launched in FP6, and further are expected over the course of FP7. See ftp://ftp.cordis.europa.eu/pub/coordination/docs/169_faq_270505.pdf for more information.

PRIVATE SECTOR PARTICIPATION

The increase in private funding of research is critical if one of the key objectives of the Lisbon Agenda is to be met: achieving 3 per cent of GDP in R&D across the European Union (compared to 1.85 per cent in 2005). Since only around 55 per cent of R&D is financed by the private sector (compared to up to three-quarters in Japan and South Korea), involving businesses more closely in research is seen as critical to achieving this goal.

Concurrently with this goal is the more general aim of bridging the gap between research and development. Too often cutting-edge research does not leave the laboratory, and it has been recognised that the link between scientists and the private sector needs to be reinforced. Both large companies and small- and medium-sized enterprises (SMEs) have a role to play. Typically, large companies have the means and scope to lead research consortiums. SMEs meanwhile can contribute through their specialised niches, and the applied knowledge they can bring.

Private involvement in Framework Programmes started in the 1980s, and was sought to be enhanced with the establishment of the ETPs that is now helping to structure the public-private relationship. SMEs in particular are encouraged to participate in all research actions and, in FP7, a significant number of SME-relevant research topics were identified in the first calls for proposals for research in the "Environment (including climate change)" theme. Given SMEs' natural interests, their main participation is in environmental technologies research, which offers the possibility of creating applications that can be brought to the market.

CROSS-THEMATIC APPROACHES

More than ever before, cross-thematic collaboration is seen as one of the goals of European research. Just as the focus has shifted from pure science and technological innovations to addressing socio-economic issues, so the need for an interdisciplinary approach has grown.

Environmental research has been at the forefront of this trend, and EU-funded environmental research projects in past and present Framework Programmes typically include researchers from many different disciplines: biologists and ICT engineers working on a biodiversity database, for example, or conservation scientists working with climatologists on cultural heritage. And this is set to continue: the FP7 "Cooperation" programme has its €32.4 billion budget divided into ten research themes, with ample opportunities for the cross-fertilisation of research interests amongst each other. In practice, this would be enhanced in particular through coordinated or joint calls for proposals among various themes. A spectacular example of such cross-thematic cooperation in FP7 is the ambitious joint call on biorefineries, which takes a life cycle approach to biofuels, and in which the Environment (including climate change) takes part. Such activities will support the EU's recently launched ambitious energy and climate change strategy.

Engineering a greener future

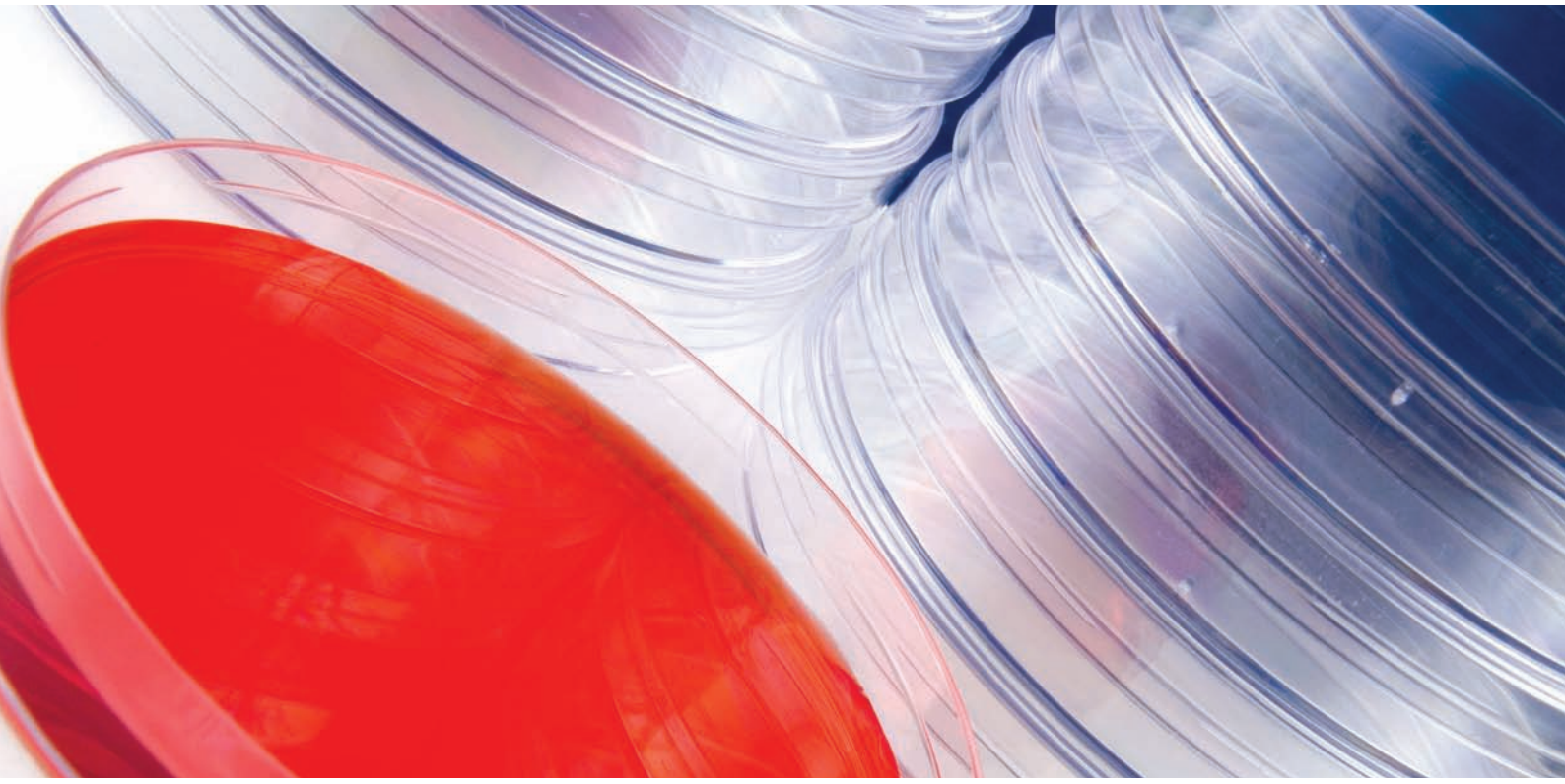
Fish used to detect water pollution in river systems. Intelligently designed buildings that can cut energy consumption by half or more. Micro-organisms that can produce detergents, vitamins or biofuels. Environmental technologies are concrete solutions to environmental problems or ones that leave a minimal environmental footprint.

The European Commission launched the Environmental Technologies Action Plan (ETAP) in January 2004[1]. The aim is to stimulate the development and use of environmental technologies by removing financial, economic and institutional barriers to their development and uptake. Indeed, environment technologies are seen as the sphere where the Göteborg and Lisbon Agendas can meet. The tension between greater competitiveness and sustainability concerns can be resolved if environmental technologies are encouraged: greater use of technology (competitiveness) with a small environmental impact (sustainability).

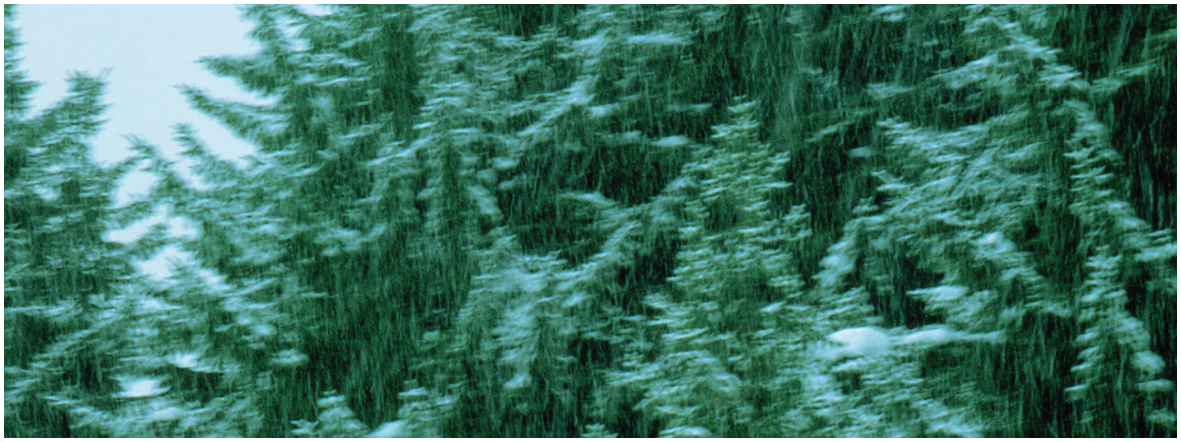
Eco-industries in the EU have an estimated turnover of some €227 billion, around a quarter of the world market, and as such the EU is a world leader in the field. However green technologies are still relatively niche (goods and services produced by eco-industries represent around 2 per cent of the EU's combined GDP). The ETAP seeks to change this situation. Market conditions need to be improved, with "green investment funds" created to reduce risks, and national road maps towards environmental technologies elaborated (including the framing of policies and incentives to bolster eco-innovation creation and use).

The links between research and markets, between scientists and end-users, also need to be closer. This can be seen in the emergence of technology platforms in EU-funded research, and the increasing participation of both large multinationals and small and medium-sized enterprises (SMEs) in research projects. By making explicit the link between research, innovation and industrial development, more environmental technologies conceived in the laboratory can find their way to the marketplace. The more the merrier when it comes to greening the economy.

1 See http://ec.europa.eu/environment/etap/index_en.htm.



10 Research **areas**



Climate change

Climate change is arguably among the most pressing concerns on the environmental agenda, and now certainly the most well-known amongst the public. From initial observations of global warming and proposed ideas about the root causes, a steady consensus has built up that climate change is one of the most serious threats facing the world today, and moreover that it is largely humanity's fault. It is therefore our responsibility to deal with it.

EU research is conducted to increase knowledge about what exactly is happening to our climate, specifically the causes and consequences. Effort is also being spent on improving our modelling so that the future climate can be predicted more accurately. Through this research, it will then be possible to develop effective adaptation and mitigation strategies that will minimise the worst impacts of climate change.

CLIMATE CHANGE RESEARCH: ITS EUROPEAN ROOTS

Research into climate change has an illustrious European history. In the 19th century Germany's Wladimir Köppen laid the foundations for climatology, while in the 1930s it was the British scientist Guy Stewart Callendar who first drew the link between rising carbon dioxide levels and global temperature.

Climate change research has been present in the EU's Framework Programmes since the 1980s. An early focus was on the stratosphere and on the ozone layer in particular. The EU was at the heart of the creation of the Intergovernmental Panel on Climate Change in 1988. In the 1990s, research concentrated on the carbon cycle – the first network, called Euroflux was launched in 1996. In the following year, the EU Member States signed the Kyoto Protocol.

Since then climate change research has proliferated in size and complexity. FP5 supported a number of projects in key action two of the environmental research programme, "Global Change, Climate and Biodiversity". FP6 supported 31 projects on climate change, with research areas ranging from atmospheric pollutants to the prediction of climate change and its impacts. The growing body of scientific knowledge helps to support future research needs and provide a more accurate picture for policymakers.

CLIMATE CHANGE IN FP7

The first sub-activity of the "Environment (including climate change)" theme in the FP7 programme, called "Pressures on environment and climate" aims to support projects that analyse the pressures on the environment and climate from natural and man-made emissions and improve our understanding of the complex climate system. Results from FP6 projects, for example from research in carbon sinks and strateospheric ozone, have been taken into consideration and emerging concerns are to be addressed, like ocean acidification and possible changes to the thermohaline circulation.

Six research areas have been identified:

1. The Earth System and Climate: Functioning and abrupt changes
2. Emissions and Pressures: Natural and anthropogenic
3. The Global Carbon cycle - Greenhouse Gas budgets
4. Future Climate
5. Climate Change Natural and Socio-economic Impacts
6. Response strategies: Adaptation, Mitigation and Policies

With the first calls in 2007, the research projects will provide a major step forward in our knowledge about climate change and the strategies needed to combat its most harmful effects.

SPOTLIGHT ON AMMA

The African Monsoon Multidisciplinary Analysis (AMMA)[17] project is one of nine climate change research projects in FP6 that focus on areas outside the EU. The €35 million AMMA project, launched at the start of 2005, brings together 131 funding and participating institutions from 28 countries in Europe, Africa and North America. Its focus is on the West African monsoon region, an area that has changed dramatically since the 1950s, witnessing progressively drier conditions. This has had major environmental and socio-economic effects.

Climate change in coming decades is likely to increase the region's vulnerability, and the AMMA project aims to provide locals with improved assessments about future rainfall patterns, as influenced by natural variability and by anticipated global climate change. Mobilising an unprecedented amount of both financial and human resources, the project will provide important insights into the effect of climate change on tropical regions. Its focus is not just on weather patterns but also on the socio-economic impact of climate and monsoon change, especially on crop yields, water resources and health.

17 http://amma.mediasfrance.org/.

Natural hazards

Floods in Europe, earthquakes in North Africa, hurricanes in the Caribbean. Mankind has been at the mercy of natural disasters for millennia. The 2004 Indian Ocean tsunami was a stark reminder to the world of how vulnerable we still are. Now the threat of climate change could bring even more such danger as the frequency of extreme weather events increase.

The scientific community has responded with various initiatives to mitigate the impact of these natural hazards. A system of beacons is being placed in the world's oceans as an early warning system for future tsunamis. Japanese researchers are world-leading in the creation of building materials and structures that can resist earthquakes. In Europe, where floods constitute the most significant natural hazard, efforts are being made to improve river management and to develop other strategies that can mitigate the effect of flooding.

DISASTER MITIGATION

The EU has supported research on natural disasters in its Framework Programmes since the 1980s, focusing on floods, landslides, earthquakes, forest fires, avalanches and volcanic eruptions – all phenomena that have affected Europe in recent years.

Natural disasters cannot really be prevented – it is beyond our means to stop hurricanes from occurring or volcanoes from erupting. Instead research has focused on providing early warning tools, as well as risk assessment techniques for pre- and post-disaster planning and mitigation. Examples of such research includes forest fire behaviour modelling or landslide and avalanche mitigation techniques.

Natural disaster research has increasingly taken a holistic and integrated approach to the management and mitigation of natural disasters. Helping to achieve this is the Euro-Mediterranean Disaster Information Network (EU-MEDIN)[18], set up during the course of FP6, which promotes the accessibility of research results, and techniques for data integration and harmonisation of methods for the disaster science community in the European and Mediterranean regions.

18 http://www.eu-medin.org/.

NATURAL HAZARDS RESEARCH IN FP7

In FP7 environmental research, natural hazards research is under a sub-activity of "Pressures on environment and climate". Research will be undertaken to improve the management of disasters. In particular, research will look into creating integrated risk assessments, including those that combine spatial planning, mapping and modelling. Furthermore a multidisciplinary approach will be taken that better understands the various factors at work as well as the impact of natural hazards on the environment and on society.

Natural hazards under the spotlight for the first round of calls included storms, volcanic threats, and avalanches, though more hazards will be covered as more feedback from FP6 projects emerge.

Natural hazards research supports the implementation of the UN International Strategy for Disaster Reduction[19] and its framework for action (2005-15), which uses a multidisciplinary and integrated approach. At the European level, research contributes to EU activities like civil protection that aims to better protect people, their environment, property and cultural heritage in the event of major natural or man-made disasters.

SPOTLIGHT ON FLOOD RESEARCH

Climate change over coming decades will probably see Europe exposed to ever greater flood risks, with major flood events in recent years raising the alarm bells about future trends. The situation has been aggravated in recent years by the unsustainable management of river systems, including construction activity in major flood plains.

EU-funded research in flood risk management has been occuring since the 1980s, but gathered noticeable pace in FP6. The €14 million FLOODsite project[20] launched in early 2004 is the largest flood research project to date, bringing together 36 partners from 13 countries. It focuses on the physical, environmental, ecological and socio-economic aspects of floods. The main expected outcome is the development of an integrated European flood risk analysis and management methodology and new techniques that support flood risk management. At the same time, CRUE[21] was one of the first environmental ERA-NETS, an opportunity for national and regional agencies across Europe to improve their cooperation in the funding of flood risk research.

19 http://www.unisdr.org/.

20 http://www.floodsite.net/.

21 http://www.crue-eranet.net/.

Environment and Health

Environmental factors like noise or air pollution can have a negative effect on human health, and opinion polls show that Europeans are increasingly concerned about the influence of these factors on their and their children's health.

There are worrying trends that reinforce this concern. Cancer rates are increasing at around one per cent per year, while fertility rates are declining. Allergies and asthma are also up around five per cent per year. Air pollution and exposure to chemicals are commonly seen as causes, while there are new environmental threats linked to emerging technologies like mobile phones and nanotechnology. Even global warming may cause unpredictable health issues, for example as climate change allows diseases to spread to previously unreachable regions.

AT THE FOREFRONT

Europe has been at the forefront of research into environment and health (E&H) for many years. One of the priorities of the fourth European Commission Medical and Health Research Programme (1987-1991) was "environment and lifestyle-related health problems", as well as research into passive smoking and chemicals exposure. The baton was also taken up by the first and second Biomedicine and Health Research Programmes (BIOMED1 and 2) during the 1990s, with themes focused on risks in occupational medicine and diseases of major socio-economic impact.

A more integrated approach to E&H began to emerge in the Fifth Framework Programme (1998-2002). E&H topics were mainly covered in the first theme, "Quality of Life and Management of Living Resources"[22], with 92 projects E&H initiated. FP6's budget for E&H research increased from around €40 to €50 million. The research was divided across four FP6 priorities: Food Quality and Safety (principal); Sustainable Development, Global Change and Ecosystems; Life Sciences, Genomics and Biotechnology for Health; and Scientific Support to Policy.

22 http://cordis.europa.eu/life/.

POLICY CONTEXT

One of the main drivers for E&H research is the European Commission's Environment and Health Action Plan (EHAP), adopted in 2004 and set to run to 2010. The plan aims to improve our understanding of the links between environmental factors and health, and is partially inspired by the need to link policy with research results. E&H is part of the Sustainable Development Strategy, and it is recognised that an early response to E&H threats will lighten the burden on public health sectors.

The European Commission also engages actively with international bodies like the World Health Organisation (WHO) on initiatives like the Children's Health and Environment Action Plan for Europe (CEHAPE)[23] and the OECD's Task Force on Endocrine Disruptors[24].

FP7 AND ONWARDS

E&H research is to receive a significant boost in overall funding during FP7. The area is also becoming more fully integrated into environmental research, and is one of the main sub-activities of the "Environment (including climate change)" theme of the "Cooperation" programme. Three priorities have been identified:

1. Health impacts of climate change
2. Health effects of environmental stressors other than climate change
3. Methods and decision support tools for environmental health risk analysis and policy development

Other FP7 themes – in particular "Health" and "Food, Agriculture, Fisheries and Biotechnology" - will complement these E&H activities. In addition, an E&H related ERA-NET is launched, allowing for greater coordination between national and regional research-funding institutions in Europe.

SPOTLIGHT ON INTERPHONE

As the take-up of mobile phones began to take off at the end of last century, increasing concerns were voiced about the potential health effects, particularly of the strong electromagnetic fields (EMFs) that they created. The European Commission responded by financing a raft of eight major research projects over the course of FP5, some of which were continued into FP6.

One of these projects was INTERPHONE (International case control studies of cancer risk in relation to mobile telephone use)[25], which brought together research teams from 13 countries in Europe and elsewhere, under the coordination of the World Health Organisation's International Agency for Research on Cancer. The focus was on three cancer tumour groups. The EU funded the international coordination effort and the work of nine research teams in the European Research Area. The results are still being processed from all the national datasets, but initial indications are that regular mobile-phone users are at little risk, though long-term and intensive use could increase risk, especially of acoustic neuromas.

23 http://www.euro.who.int/childhealthenv/policy/20020724_2.

24 http://www.oecd.org/document/63/0,3343,en_2649_34377_2350207_1_1_1_1,00.html.

25 http://www.iarc.fr/ENG/Units/RCAd.html.

Natural resources management

An implicit goal of environmental research is about getting to know the human impact on the environment with a view to minimising its negative effects. Indeed sustainable development, a major goal of the European Union is precisely about that – making sure our current economic growth and way of living does not jeopardise that of future generations.

As our economic growth and way of living is based to a large extent on the exploitation of natural resources, it is essential that we learn to better manage these resources to make sure our exploitation is not detrimental. Of these natural resources, soil and water are the most critical: prudent soil and watershed management are essential for our own wellbeing, while research into desertification helps us to understand the processes by which soil and water resources are depleted.

DEVELOPING RESEARCH, SUPPORTING POLICY

EU-funded research in soil and watershed management and desertification issues has been going on for many years. An early example of research was based on concern with the state of Europe's waterways, and during FP4 a number of projects focused on new pollution prevention techniques, like the bioreactor developed to treat water polluted with hydrocarbons (called BIOTREAT).

This effort was accelerated in FP5. One of the key actions of the "Energy, Environment and Sustainable Development" programme focused on the sustainable management and quality of water. Research was also conducted into preventing land degradation and desertification, continuing a theme that environmental projects had focused on during the 1990s.

One of the nine main research areas in FP6 was on the water cycle, including soil-related aspects, with over fifty projects supported. In line with research trends, the focus was on interdisciplinarity, with research themes like integrated management strategies and the link between hydrology and the climate process. A good example of this was Euro-limpacs[26], an FP6 integrated project that evaluated the impacts of global change on European freshwater ecosystems. Desertification was also tackled in an integrated manner: for

26 http://www.eurolimpacs.ucl.ac.uk/.

example, DeSurvey[27] was an FP6-funded project that sought to deliver a compact set of integrated procedures that aimed to complement desertification assessment tools with early warning and vulnerability forecast systems.

This research is directly linked to the EU's 6th Environmental Action Programme, one of whose thematic priorities is the sustainable use of natural resources, as well as the (renewed) Sustainable Development Strategy[28]. As far as the research components are concerned, soil research links into the Soil Thematic Strategy[29], while watershed management research contributes to the Water Framework Directive[30] as well as the EU Water Initiative (EUWI)[31] that contributes to the safe drinking water components of the UN Millenium Development Goals. Finally desertification research is linked to the UN Convention to Combat Desertification[32], to which the European Community and its member states are signatories.

NATURAL RESOURCES IN FP7

"Sustainable management of resources" is one of the four main activities of the FP7 work programme, and incorporates natural resources, man-made resources (the urban context) and biodiversity. Research into integrated resource management, water resources and soil research and desertification continue to be supported. New research initiatives include river-basin twinning and helping international cooperation partners get involved in integrated resource management. Another research area, linked more to land management, will focus on integrated forest research, and is expected to build on previous efforts undertaken in sustainable forest resource management.

FP7 research will improve the knowledge base and develop advanced models and tools necessary for sustainable management of resources, helping to mitigate resource degradation. Soil research will be influenced by the Thematic Strategy for Soil Protection developed by DG Environment.

SPOTLIGHT ON AQUATERRA

AQUATERRA[33] is a €20 million project funded under FP6. The integrated project, bringing together 45 institutions from across Europe, started in mid-2004 with a timescale of 60 months. It aims to provide the scientific basis for improved river basin management by investigating the river-sediment-soil-groundwater system as a whole, and by integrating both its natural and its socio-economic aspects – looking at a variety of such systems both in time and in space, and from a micro to a regional scale.

AQUATERRA aims at a better understanding of the system as a whole by identifying relevant processes, quantifying the associated parameters and developing numerical models of the groundwater-soil-sediment-river system to identify adverse trends in soil functioning, water quantity and quality.

The project has a strong interdisciplinary focus, aiming to bring out new insights through combining different scientific fields. Given its large scope, the project has been divided into eleven sub-projects, ranging from investigations into the transport and turnover of inorganic and organic solids and solutes (called FLUX) to COMPUTE, which models the fate of pollutants at different scales.

27 http://www.desurvey.net/.

28 http://ec.europa.eu/environment/eussd/.

29 The following webpage provides a good overview: http://ec.europa.eu/environment/soil/index.htm.

30 http://ec.europa.eu/environment/water/water-framework/index_en.html.

31 http://www.euwi.net/.

32 http://www.unccd.int/.

33 http://www.attempto-projects.de/aquaterra/.

Biodiversity

Biodiversity is the rich array of life on Earth, with all its interactions and beauty. It includes both wild and cultivated species, and not only serves human needs but also underpins human wellbeing. Unfortunately human activities are causing a rapid loss of biological diversity – and the ecosystems it comprises – across the world.

The UN's Millennium Ecosystem Assessment[34] found that most of the planet's ecosystems are degraded or managed unsustainably. Biodiversity loss is almost always irreversible – especially when it comes about through species extinction. The loss of biodiversity often has significant impact on human activity and wellbeing, especially when that loss makes it difficult for an ecosystem to provide a service on which humans depend.

In Europe, decades of overuse of natural resources has led to significant species depletion and biodiversity loss. Some 600 species of European animal and plant species are threatened with extinction. Large mammals that once roamed Europe are now almost everywhere absent. Birds that were common in the recent past are gone; frogs, fish, flowering plants... the list goes on and on. The habitats of many migratory species are under threat, but so are certain breeds of domestic stock, while strains of fruit and crops that once characterised specific regions of Europe are now gone or endangered.

Extinction need not be global to have an effect. Even local extinction of some key species, including for example top predators, or pollinators, can have significant environmental effects.

PRESERVING BIODIVERSITY

European research is focused on assessing and forecasting changes in biodiversity and understanding the dynamics of different habitats and ecosystems, both terrestrial and marine. The relationship with society and the economy are also investigated in order to comprehend what the harmful effects are, both on the environment and on human health and society, and how these can be mitigated.

34 http://www.millenniumassessment.org/en/index.aspx.

Through such research, biodiversity risk assessments can be formulated that will allow us to better manage, conserve and rehabilitate our ecosystems, enabling our society to switch towards a more sustainable development trajectory.

Framework Programmes have been supporting biodiversity research for many years. During the 1990s, much of this research was concentrated on understanding marine biodiversity, like the FP4-funded MIDAS project that looked at biodiversity in microorganisms[35]. Ecosystem vulnerability was also a concern in FP5, with projects focused on assessing and conserving biodiversity. In FP6, "Biodiversity and Ecosystems" was one of the main areas of environmental research, with 38 different projects supported, looking at a range of themes from taxonomy to the impact of trees on biodiversity.

As biodiversity research has gathered pace, the need for better networking and integration has materialised. Since 1999, the main European organisation in this respect has been the European Platform for Biodiversity Research Strategy (EPBRS)[36] which has driven the EU biodiversity research agenda and worked to ensure that the research contributes to halting the loss of biodiversity.

CONTINUED EFFORTS IN FP7

FP7 research on biodiversity builds on the efforts made from previous research. Biodiversity research can be found mainly in the sustainable management of resources and management of marine environments activities and will be focusing on the social, environmental and economic contributions of biodiversity. The work supports the EU's proposed Action Plan on halting the loss of biodiversity by 2010[37].

Biodiversity is also being approached as a cross-thematic research theme, and research projects that address biodiversity concerns can be found in other FP7 Cooperation research themes like Food, Agriculture and Fisheries. In addition, under the FP7 Capacities programme, a major €370 million biodiversity research infrastructure called Life Watch34 is also to be set up.

SPOTLIGHT ON ALARM

The ALARM project (Assessing Large Scale Risks for Biodiversity with Tested Methods)[38] is a €16.7m biodiversity project funded under FP6 that brings together 54 institutions from Europe and beyond. Based on a better understanding of biodiversity and ecosystem functioning, it proposes to develop and test methods for assessing major environmental risks and human impacts especially on biodiversity and ecosystems. The project builds on previous biodiversity research, helping to integrate the results and proposals made.

New methods being developed include one that focuses on socio-economic pressures using a step-by-step methodology, evidence that research on biodiversity loss necessarily requires an interdisciplinary and holistic approach.

35 http://cordis.europa.eu/data/PROJ_MAST/ACTIONeqDndSESSIONeq137532oo595ndDOCeq4ndTBLeqEN_PROJ.htm.

36 More information can be found on their website: http://www.epbrs.org/.

37 http://europa.eu/rapid/pressReleasesAction.do?reference=IP/06/667&format=HTML&aged=0&language=EN&guiLanguage=en.

38 http://www.alarmproject.net/alarm/.

Marine Environment

The world's oceans and seas cover around 70 per cent of the Earth's surface, yet our knowledge about them is still limited. Oceans are home to an enormous range of species, many still undiscovered, from the largest known animal, the blue whale, to centuries-old coral and the microscopic phytoplankton that play a vital role in determining Earth's climate. The oceans are also an integral part of our climate system, important vectors for transporting weather across the world and climate regulators in their own right.

Humanity's relation with the marine environment has for centuries been one of exploitation, yet it is only as the environmental threats emerge that we are beginning to learn about the complexity and richness that they contain. And environmental degradation in the marine environment is likely to have a major impact on the planet as a whole and humanity in particular, especially as around 40 per cent of the world's population live within 100km of the coastline and hundreds of millions are dependent on the oceans for their livelihood.

MARINE RESEARCH

Despite its small relative size, Europe has a very large coastline (of around 200 000 km), around double the size of Africa's[39]. With a long and rich maritime history, it is only natural that Europe also has a rich marine research heritage.

Early examples of EU-funded marine research include EROS (European River Ocean System)[40], an interdisciplinary project started in 1988 that set out to gather information about Europe's coastal environment, and the Marine Science and Technology (MAST) programme[41] that ran throughout the 1990s.

Marine research is increasingly set within the context of EU policies. Following extensive consultations, the European Commission launched in October 2007 an integrated maritime policy for the European Union through the "Blue Book". The new policy seeks to integrate different maritime activities, building on strengths in European marine research, technology and innovation. It is anchored in the Lisbon Agenda's focus on jobs and growth while respecting the overarching commitment to environmental sustainability.

39 See http://earthtrends.wri.org/text/coastal-marine/variable-61.html for figures.

40 http://cordis.europa.eu/eesd/src/mtr_putting.htm.

41 http://cordis.europa.eu/mast/home.html.

MARINE RESEARCH IN FP7

"Management of marine environments" is one of the main sub-activities of the Environment (including climate change) research theme. Specific research will focus on improving our understanding of the impacts of human activities on the ocean and seas and on marine resources. The seas that surround Europe, from the Black Sea to the Baltic, are facing serious environmental threats, and much of the research will be investigating processes such as pollution and eutrophication. Deep sea ecosystems, one of the least known of the marine environments will be a particular focus of research interest.

With the first FP7 calls launched in 2007, several projects due to be supported have a wide thematic scope: from an investigation of habitat-species relationships to life forms in extreme environments. By increasing our knowledge about the complex marine world, we can mitigate the damage we are doing to it. In later calls, research into environmental technologies geared for the marine environment will help to lessen the negative impact of human activity.

SPOTLIGHT ON MARBEF

As human threats to the coasts and seas around Europe are increasing, it is necessary to tackle the problem using a more holistic approach and at a global level. The project called Marine Biodiversity and Ecosystem Functioning (MarBEF)[42] is one of eight networks of excellence (NoE) funded during FP6. The EU is contributing €8.7 million to this project which started in February 2004 with a timeframe of 60 months. It aims to integrate research by bringing together more than 700 marine scientists from 92 institutes (56 as project partners with a further 36 associated).

The project has the challenging goal of creating a virtual European Institute on Marine Biodiversity with a long-term research programme and dedicated links to industry and the public at large. At the same time, the research interests are highly diverse including, but not limited to, marine ecology, taxonomy, and socio-economic sciences. The aim is therefore not just research integration within the same scientific fields but across disciplines as well.

42 http://www.marbef.org/.

Land and urban management

Research into urban, rural and coastal management is all about sustainable development: urban management focuses on sustainable cities, rural management focuses on sustainable agriculture and rural livelihoods and coastal management focuses on the sustainable development of coastal regions. These are all interrelated under the umbrella of "sustainable multifunctional land management".

Land is subject to intense pressure, as in the case of intensive agriculture. These stresses may affect biodiversity as well as impact on rural society. The challenges that we face in creating a model of sustainable agriculture are obvious. The shift to a production pattern that is less intensive and puts less pressure on natural resources still needs to be implemented, and will also involve changes in the food production, distribution, and consumption systems.

Around 75-80 per cent of Europeans live in towns and cities[43], and with urbanisation gaining pace across the world, the quality of city life is under the spotlight, with dangers like pollution, traffic congestion, and disease contagion all risks. The need to create sustainable cities and towns is therefore very urgent if the goal of sustainable development is to be reached.

Europe's coastal regions are also under increasing pressure, with around two-fifths of the total European population living on or near the coast, alongside increasing migration and construction development, especially in the Mediterranean region[44]. Competing interests like tourism, industry and environmental conservation add to the threats that vulnerable coastal ecosystems face.

RESEARCH ROOTS, POLICY PRESCRIPTIONS

EU research into urban, rural and coastal management has strong antecedents. New urban planning and transportation methods were the focus of concentrated research during the 1990s[45]. FP5 had a strong urban management component with its key action "The city of tomorrow and cultural heritage", introducing the relevance of cultural heritage to the concept of sustainable development for the first time.

43 http://grida.no/geo/geo3/english/420.htm.

44 See http://epaedia.eea.europa.eu/page.php?pid=504 for a discussion of the environmental threats facing Europe's coasts.

45 http://www.lutr.net/.

Research on land management focused on multifunctional land uses, looking at land from a holistic perspective to understand how different patterns of use cause different stresses, what the consequences of these stresses are, and how they can be managed or corrected. Research looked at land use in terms of soil, agriculture, forestry resources and coastal zones, investigating the supply chains that link them to the wider economy / society to ensure they were being used sustainably.

All this research has fed into the policy pipeline. In 2006 the European Commission launched the Thematic Strategy on the Urban Environment[46], one of seven foreseen in the 6th Environmental Action Programme. Informed by extensive research, the strategy proposes a variety of actions in environmental management, sustainable urban transport, training, and exchanges of best practice and dialogue between local authorities. Similar strategies are being developed for soil protection[47]. In 2007, the Commission also released new guidelines for Integrated Coastal Zone Management[48].

The European Union also leads the way as concerns its international commitments in urban, rural and coastal management. These include the UN Human Settlements Programme, UN HABITAT[49] and participation in the Aalborg Commitments initiative[50] for sustainable cities. Examples of supporting research include the FP6-supported SUSTAINFO project[51], that set up a research database and publications that support local authorities and experts in developing local sustainable development initiatives, as well as PLUREL, the Peri-urban Land Use Relationships project that researches strategies / sustainability assessment tools for urban-rural linkages.

THE FP7 CONTRIBUTION

In FP7, one of the research areas focuses on urban development, part of the "Sustainable management of resources" activity. The initial call concerns urban metabolism and methods of optimising resource use. Research dedicated to integrated water resource management is also expected to look at coastal management.

SPOTLIGHT ON SPICOSA

SPICOSA[52] is an acronym for the €14.6 million project Science and Policy Integration for Coastal System Assessment. The project forms part of efforts to improve Integrated Coastal Zone Management and improve the sustainbility of coastal systems. A multidisciplinary assessment framework is being developed that balances ecological, social and economic aspects – using a holistic approach that can help to reconcile often conflicting interests.

Bringing together 54 institutions, the project was launched in 2007, at the end of the FP6 cycle. The main goal will be the creation of an operation Systems Approach Framework (SAF) that can effectively assess different policy alternatives. Strategically the project will also confront the important challenge of multidisciplinary science in creating a working science-policy interface that can accurately describe complex systems like Europe's coastlines.

46 See http://ec.europa.eu/environment/urban/home_en.htm.
47 http://ec.europa.eu/environment/soil/index.htm.
48 http://ec.europa.eu/environment/iczm/home.htm.
49 http://www.unhabitat.org/.
50 http://www.aalborgplus10.dk/.
51 http://www.susta-info.net/.
52 http://www.spicosa.eu/index.htm.

Environmental technologies including cultural heritage

Environmental technologies are those tools and applications that can decrease material inputs, reduce energy consumption and emissions, recover valuable by-products and minimise waste. In general they are lean and resource-efficient technologies that can help to reduce the impact on the environment.

Environmental technologies are about greening the economy and as such are the missing link between raising competitiveness in the European economy and making sure that our development is sustainable.

POLICY CONTEXT

The strategic importance of environmental technologies has been highlighted by the EU's Environmental Technology Action Plan (ETAP)[53] launched in 2004 by both DG Environment and DG Research. The main axes of the Action Plan are getting the technologies from research to markets, improving market conditions and acting globally. Improving the take up of environmental technologies means reinforcing the links between research institutions and industry. The creation of the European technology platforms, that create public-private partnerships on a specific research topic, for example in water research or in photovoltaics, are helping this process.

Market conditions need to be stimulated, and there are many tools that can be used for this. Policymakers can set performance targets that encourage environmental technologies. Another popular tool is environmental financing arrangements or tax concessions. Finally governments can act as end-users, stimulating demand by opening up public procurement to green products.

Environmental technologies are not just meant to help Europe, but can be used throughout the world. Environmental technologies need to be developed and promoted in the developing world, in particular, hardest hit by environmental threats but often without the means to develop such technologies on their own. The EU is therefore committed to supporting eco-technologies in the developing countries and promoting foreign (green) investment.

53 http://ec.europa.eu/environment/etap/index_en.htm.

CUTTING EDGE IN FP7

Environmental technologies research in FP7 will use a systems approach, aiming to integrate all components of the process while taking into account external factors, thus helping to decouple growth from resource depletion. The environment of technological creation will also be considered, from eco-efficiency assessments to considerations about life cycle management and market barriers.

Environmental technologies research constitutes one of the five major activities of the Environment (including climate change) research theme. The activity is divided into three sub-activities. The first groups together environmental technologies that tackle five research areas: water, soil, waste, clean technologies, built and marine environments. The second focuses on environmental technologies that work towards the protection of cultural heritage and human habitats, and the last focuses on environmental technology assessment, verification and testing. Environmental change is one significant threat to the sustainability of the European cultural heritage. To tackle this challenge stronger research efforts will be devoted, all over FP7, to better assess and further understand the damage mechanisms, and find the best possible measures and means to ensure the preventive conservation of cultural heritage especially through advanced technologies and tools. A high transferability of results especially to sensitive cultural heritage sites, in Europe and beyond, is expected.

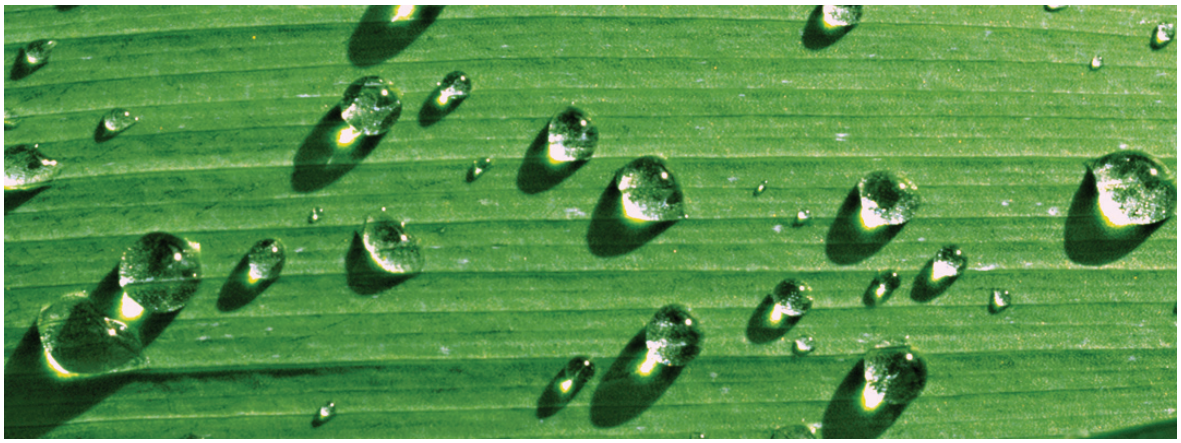
SPOTLIGHT ON MIDAIR

The concern with greenhouse gases in the context of climate change is obvious. Less obvious is the link with farms. Yet intensive farming, with the use of chemical fertilisers, and dairy farms in particular are an important source of these gases. The Greenhouse gas mitigation for organic and conventional dairy production (MIDAIR)[54] project was a 3-year research effort that started in 2001, aiming to identify mitigation measures and strategies for dairy farms in Europe.

MIDAIR brought together 19 agricultural and environmental research organisations from across Europe with two main objectives: arriving at a better estimate of the nitrogen and carbon flows derived from dairy farms; and investigating mitigation options. For the first a model was developed called FarmGHG that describes inputs, outputs and internal flows through the dairy farm, thus accounting for the whole supply chain. Evidence suggested that a bottle of milk from intensive dairy farming produces more greenhouse gases than those produced less intensively.

Mitigation strategies therefore show that less intensive farming is the best option for greenhouse gas reductions. Failing that, efforts to improve manure utilisation were focused on, by mixing straw and using covers to reduce aeration, allowing surface crusts to develop on stored slurry, or developing manure and methane as substitutes for conventional fossil fuel energy use.

54 http://cordis.europa.eu/search/index.cfm?fuseaction=result.simpledocument&RS_RCN=9135275&CFID=3219188&CFTOKEN=54339917.



Earth observation

Humans have always observed the earth: watching the changing season to predict the best time for harvesting, or the night sky while navigating at sea. Scientific research over the ages has enhanced these skills so that the scale and the precision of our observations have increased markedly.

Now research efforts in the field of earth observation are seeking further integration of land and sea-based sensor networks with space-based platforms that can allow us to observe and compare on a global scale. Better coordination and integration means better results, giving policymakers more accurate information as they draw up environmental legislation to protect society and nature.

INCREASING SCRUTINY

Europe is one of the world's leading players in the advancement of EO technologies and related environmental applications. European remote-sensing satellites cover all of the Earth's climatic zones, while European ground-based, air-based and ocean-based monitoring devices serve users by providing high quality observation data for subjects as diverse as urban planning, adaptation to climate change, disaster reduction, disease control and humanitarian relief.

Examples of earlier Framework Programme-funded research include:

- ESONET[55], an FP6 network of excellence that aims to promote the implementation and the management at the European-scale of a network of long-term multidisciplinary observatories in European seas; and
- AMMA[56], an FP6-funded integrated project that aims to improve our ability to predict the West African Monsoon, a natural phenomenon of crucial importance to the Sahel region;

Earth observation projects are increasingly being integrated into the Global Earth Observation System of Systems, or GEOSS, which brings together 71 partner countries from around the world as well as the European Commission (see Spotlight).

55 http://www.oceanlab.abdn.ac.uk/research/esonet.php.

56 http://amma.mediasfrance.org/.

FP7 EFFORTS

In FP7, Earth Observation is dealt with in the sub-activity, "Earth and ocean observation systems and monitoring methods for the environment and sustainable development". Research activities relevant to the sub-activity will be implemented through annual calls from 2007 until 2013.

Four building blocks toward the establishment of GEOSS are emphasised:

1) Integration of European activities within GEO, with a project on the monitoring of the carbon cycle at the global level and a contribution to a global biodiversity observation system;
2) Cross-cutting research activities relevant to GEO with a research topic on environment and health foreseen in 2009-2010;
3) Emerging earth observation activities, with projects monitoring the ocean interior, seafloor, and sub-seafloor, and participating in the development of a Global Soil Observing System;
4) Developing capacity building activities in the domain of earth observation in the EU and in developing countries, with several projects working on a georesource information system for Africa, improving observing systems for water resource management, and GEONETCast applications for developing countries.

Research activities funded in the first round of FP7 calls both contribute to GEOSS and benefit from the know-how and collaborations with international partners. Future calls are foreseen on topics that address the social priorities of GEOSS. Examples include projects to develop meteorological hazard observation systems or earth observation in support of the EU Technology Platform on Sustainable Mineral Resources.

SPOTLIGHT ON GEOSS

The Global Earth Observation (GEO) is an intergovernmental body of 71 member states, the European Commission and 46 organisations. The mandate of GEO, outlined in 2005 in a ten-year implementation plan, is to strengthen cooperation and integrate earth observing systems to create GEOSS, the Global Earth Observation System of Systems.

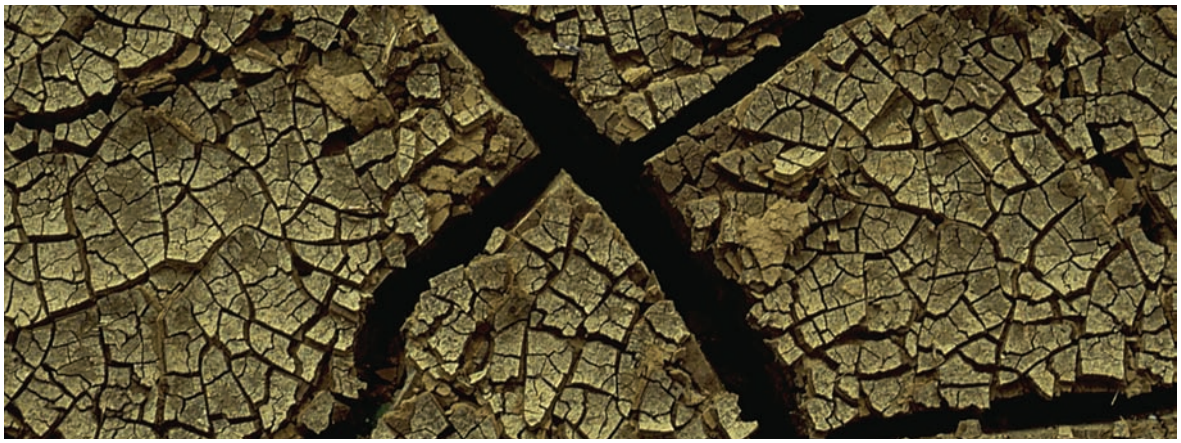
GEOSS will address a number of social concerns:

- reducing loss of life and property from natural and human-induced disasters;
- understanding environmental factors affecting human health and wellbeing;
- improving the management of energy resources;
- understanding, assessing, predicting, mitigating, and adapting to climate variability and change;
- improving water resource management through a better understanding of the water cycle;
- improving weather information, forecasting, and warning;
- improving the management and protection of terrestrial, coastal, and marine ecosystems;
- supporting sustainable agriculture and combating desertification;
- understanding, monitoring, and conserving biodiversity.

GEOSS is a step towards achieving the UN Millennium Goals[57] and the EU's Sustainable Development Strategy[58]. It will also help the further implementation of environmental treaty obligations. Improved observation will allow for more accurate predictions about the future state of our world.

57 http://www.un.org/millenniumgoals/.

58 See http://ec.europa.eu/environment/eussd/ for more information about this.



Assessment tools for sustainable development

Sustainable development is a complex concept encompassing economic, social and environmental concerns. As the concept is translated into practice and policy, it is increasingly urgent to create assessment tools that can effectively monitor its successful implementation – tools that can for example assess the sustainability of public work projects.

Sustainable development was defined by the UN Brundtland Commission[59] in 1987 as development that "meets the needs of the present without compromising the ability of future generations to meet their own needs". Sustainable development is now also accepted as one of the core objectives of the European Union. At its 2001 meeting in Gothenburg, the European Council adopted the Sustainable Development Strategy (SDS)[60]. After a five-year period the Strategy was renewed in June 2006[61], making explicit the key challenges and the actions required to address them. These are:

- Climate change and clean energy;
- Sustainable transport;
- Sustainable consumption and production;
- Conservation and management of natural resources;
- Public health;
- Social inclusion, demography and migration; and
- Global poverty and sustainable development challenges.

The renewed SDS was elaborated at the same time as FP7, and it is safe to say that they reflect each other. In particular, the need for sustainable development research expressed by the SDS is taken into account throughout the entire seven-year Framework Programme.

SUSTAINABLE PRECEDENTS

Sustainable development research has only become explicit since the late 1990s, as the concept of sustainable development gained ground. One of the four thematic programmes of FP5, which ran from 1998 to 2002,

59 The Commission was named after its chair, the Norwegian politician, Gro Harlem Brundtland. See http://www.un-documents.net/wced-ocf.htm for the whole report.

60 http://europa.eu/scadplus/leg/en/lvb/l28117.htm.

61 http://register.consilium.europa.eu/pdf/en/06/st10/st10117.en06.pdf.

was called “Energy, Environment and Sustainable Development”. Bringing together both environmental and energy research, the stated aim of this programme was to contribute to sustainable development by focusing on key activities crucial for social wellbeing and economic competitiveness in Europe.

It was the first time that sustainable development was seen as a cross-thematic research issue. FP6 continued the trend. In the “Sustainable Development, Global Change and Ecosystems” programme, sustainable development was still primarily an energy concern (focused on sustainable energy and transport systems), but it was also present in the “Global Change and Ecosystems” priority. This was devoted to environmental research and the last research area was devoted to Sustainable Development concepts and tools as a cross-cutting issue horizontal to other research areas.

SUSTAINABLE DEVELOPMENT IN FP7

As the decision that paved the way for FP7’s launch in December 2006 states, the “overarching aim” of the €32.4 billion “Cooperation” programme is for “sustainable development”. Sustainable development has therefore been mainstreamed: projects touching or focusing on sustainable development can be found throughout the research programme, not just in environmental research.

The last sub-activity of the Environment research theme is called “Forecasting Methods and Assessment Tools for Sustainable Development taking into account Different Scales of Observation”. The first calls have a threefold focus:

- Developing impact assessment tools that can identify policy impacts at a disaggregated level, and that can study the implications of EU budget scenarios, as well as trade and cooperation policies, on sustainable development.
- Developing sustainable development indicators that bridge mainstream indicators with sustainable development objectives, in particular by linking economic, environmental and social concerns.
- The third area focuses on policies to promote sustainable consumption patterns as well as engaging civil society organisations to get involved in research and help provide innovative approaches and solutions.

SPOTLIGHT ON NATURNET-REDIME

The NATURNET-REDIME project, funded under FP6, developed educational tools that help us understand sustainable development. It has two components. Firstly NATURNET is creating a web portal that brings together scattered sustainable development data from around the world in one interoperable internet architecture. Secondly REDIME concentrates on “learning through modelling”, by integrating qualitative reasoning (QR) tools that are being developed in artificial intelligence research. The idea is to translate the knowledge generated by sustainable development specialists into tools that can be exploited on the Internet.

NATURNET-REDIME brings together 19 partners from across Europe and Brazil, including ICT and environmental researchers, as well as end-users such as schools and municipalities. The collaboration between web technicians and environmental scientists has opened their eyes to the potential of such cross-cutting work. The tools developed have a local focus, based on eight project regions, but they can easily be adapted to other areas. The tool should become very useful for raising awareness (especially in schools) and for helping to simplify impact assessments (especially for local authorities).

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