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A European Research Area for the Environment

Assessment of progress and recommendations for the future

STUDIES AND REPORTS

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Assessment of progress and recommendations for the future

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TABLE OF CONTENTS

p.

0 EXECUTIVE SUMMARY

0.1 Background

European Research Area and the 'Grand Challenge' on environment…

In 2007 the European Research Area (ERA) was put high on the European policy agenda through the publication of the 'ERA Green Paper[i]' and the launch of various related policy initiatives. The importance was reconfirmed during the Informal Meeting of Ministers for Competitiveness in 2008[ii][iii]. Furthermore, the concept of the ERA is now a fully fledged component of the Lisbon Treaty. The recent 'Europe 2020 Flagship Initiative Innovation Union' communication [iv] emphasizes the importance of the realization of the ERA even further: *"…the European Research Area must have been completed within four years",* i.e. by the end of 2014.

In 2009 the European Commission (DG Research) launched a study aiming at taking stock of the ERA progress in the field of the environment, and to move forward and further promote the realisation of the ERA in this field. The study developed a framework of objectives and indicators to understand and measure the progress in each of the six ERA dimensions[v]. A large variety of data and indicators[vi] has been collected on national and European levels. The study team carried out an exploratory web-survey and a number of follow-up interviews with Member State representatives and experts.

In the section below we present our conclusions and recommendations according to six dimansions of the environmental ERA for which the corrent situation and the progrtess were assessed:

1. Well-coordinated research programmes and priorities
2. An adequate flow of competent researchers
3. Excellent research institutions
4. World-class research infrastructures
5. Effective knowledge sharing
6. A wide opening of the European Research Area to the world

0.2 ERA progress in environmental research

There is progress towards ERA en the field of environment, but it is mainly triggered by EU policies… and it is still hampered by legal barriers… and lack of long-term and high-level strategic planning…

More ERA becomes visible in the field of environment…

Compared to the state of affairs in 2000, progress is observed towards the realisation of the ERA objectives in environmental sciences in almost all six specific ERA dimensions. There is an upward trend in many of the environmental ERA progress indicators. Progress in the field of environment has also contributed to the implementation/institutionalisation of the European Research Area on various levels.

EU policies and support instruments have had a strong impact…

The policies and the research support instruments initiated and administered at the EU level have facilitated the growth of the ERA in the field of environment (e.g. ERA-NETs, collaborative and integrated projects, Marie Curie Actions, European Technology Platforms). At national levels, different policy initiatives towards more ERA in the field of environment can be found, but significant barriers remain towards greater coordination and harmonisation of policy support measures, and governance thereof. An overarching and strategic approach, across governance levels, is currently lacking, although the newly introduced 'innovation partnerships' provide opportunities to move in this direction.

Legal barriers remain…

There are also many legal barriers (e.g. on cross border research funding, language laws, evaluation and funding cycles) that slow down the real ERA development 'on the ground'. National and international efforts towards developing ERA in environmental research, while being aimed at overcoming the existing fragmentation, fall short of fully achieving this objective. We find the creation of environmental 'ERA development clusters' (e.g. the ERA-NETs, ETPs, JTIs, bilateral international treaties, etc.) which coordinate the efforts of their members and related stakeholders, but at the same time 'forget' to coordinate among themselves.

A fragmented policy system is aiming to

On top of several, mainly EU-driven, ERA promotion mechanisms, a number of new and promising initiatives have only recently been launched, and their success/failure cannot be fully judged at this point in time (e.g. Joint Programming Initiative, or the Knowledge and Innovation Communities, and even the newly presented Innovation Partnerships).

Recommendations at strategic level

Create ownership and support for ERA at the national, regional and local levels. This needs policy orchestration between national and regional levels, and between different DGs inside the European Commission.

Join forces in tackling fragmentation. This is in particular the case for SME-support, where e.g. an integrated multi-instrument approach is advisable, based on intensive coordination at EU and MS levels.

1. *More coordination and joint prioritisation is reality, but national research governing and funding principles are still quite different…*

Coordination of research programmes and priorities ..

The supra-national character of the environmental challenges is expected to influence the coordination and orchestration of environmental research policies; not only for reasons of efficiency, but also for reasons of effectiveness in dealing with challenges that are too big to handle from a single national perspective. In environmental research policy making, the involvement of multiple stakeholders is increasingly becoming common practice (through the ETPs, ERA-NETs, KICs, etc.) just as Joint Programming Initiatives (yet at its infancy), joint implementation and joint evaluation of project applications. This collective involvement is a necessary condition for better coordinated research programmes, but it is yet far from being sufficient and far from massive enough. High-level coordination and joint prioritisation is still lacking.

The harmonisation of research governing principles and practices between selected countries is slowly but surely taking place, triggered by EU initiatives (such as Open Methods of Coordination, the ERA-NETs etc., which provided national policy makers with experience in collaborative research management and decision making) and based on bottom-up processes (e.g. through experiences of programme managers gained in the joint FP projects and ERA-NETs). At the same time, national funding and evaluation principles are far from being fully harmonized.

It can be observed that the majority of national and international efforts in the field of environmental research deal with regional/local environmental problems and/or aim at achieving progress at a relatively limited geographic scale and scope. There is also evidence of the 'local' tackling of what are mainly global environmental challenges.

Recommendations

Develop policy making capacities for answering "societal" issues at EU (and global) level is essential. "Round table" or "science meets policy" meetings (involving MS ministries of environment and research and EU DG's) could be renewed and broadened. Especially in the area of environmental sciences, it is important to emphasize the societal dimension and to communicate to the society at large results and progress achieved.

2. *In general, environmental students and researchers are more mobile than in the past, but barriers mainly with respect to 'cross-sectoral' mobility remain …*

An adequate flow of competent researchers…

Geographical mobility of students (in environmental protection) and researchers (in the natural sciences) increases steadily over time. Whether this growth is fast enough to meet the demand from the environmental ERA remains to be seen (as large numbers of researchers are needed in relation to the 3% R&D objective).

Mobility between environmental research disciplines and between the public/private sectors is not that common yet. This makes this type of knowledge sharing and industry-academia collaboration difficult, and also slows down the valorisation of research. It is the fact that the single labour market (and not only in environmental sciences) needs further development, as research institutions and universities do not seem to have sufficient administrative autonomy to overcome the existing legal barriers and move any faster.

Recommendations

Carry out joint (among MS) reviews and analysis of education programmes and existing mobility schemes for the subject of their better use towards bridging the identified skill gaps. The leading EU environmental research institutions should be better showcased to increase Europe's attractiveness as a destination for mobile researchers.

Develop an inventory of (future) skill shortages (threats) and mobilize the right actors, academic organisations, industry representatives in doing so. Environmental ETPs (like all ETPs) have a clear mandate here and could/should be engaged.

3. *Europe has excellent environmental research institutions, but there is still too much 'unwise' competition as a result of insufficient strategic alignment and prioritisation…*

Excellent research institutions…

In environmental research, Europe has a number of excellent research institutions that compete at a global scale based on their scientific and technological output.

The model that considers a clear cut distinction between not optimal 'competition' and beneficial 'collaboration' does not (fully) apply to the leading EU institutions, that still do not sufficiently collaborate on the strategic level. There is 'unwise' competition, whereas smart specialisation and collaboration could be much more beneficial. The ambition of new Member States to build up capabilities similar to the ones in the old Member States is not the best option in this respect, and will lead to sub-optimization from the European perspective.

The lack of a long-term common vision diminishes the positive effects of current collaborations, which still can exhibit duplication of efforts and excessive inter-group competition. The leaders should join efforts.

Recommendations

Stimulate cross border research funding by developing specific 'economic' stimuli to this end. E.g. financial mechanisms to make cross border funding possible and attractive (e.g. through taxation impulses) could be useful; monitoring of progress on a MS level (progress towards EU 2020 Vision and objectives) is also essential.

Investigate 'strategic' collaboration possibilities among leading European environmental research institutions not only at the level of individual research institutions, but also at the level of network and/or national programmes in order to avoid unnecessary duplication (to be taken up by LERU, EARTO, EIRO and others).

4. *Integration and networking of environmental infrastructures has increased, common prioritisation as a result of ESFRI has been successful. But, more 'real' collaboration inside and also outside Europe is needed.*

Worldclass research infrastructure…

The integration and networking of environmental infrastructures (on the basis of FP involvement) has been increasing. Coordination among environmental research infrastructures themselves could nevertheless be improved and brought to the level of inter-consortia cooperation and coordination.

The accessibility (i.e. sharing) of environmental research infrastructures appears to be quite high, both to researchers form inside and outside Europe.

The EU ESFRI roadmap has played a significant role: there is increased coordination in the development of and investment in major environmental research infrastructures in Europe. At the same time, the existing infrastructures and research facilities do continue to provide a competitive edge to domestic (incumbent) researchers in the race for international public R&D funds putting them in an advantageous position when facing potential competition of foreign researchers in the same field (both from industrialised and developing countries).

Recommendations

Stimulate collaboration among environmental EU infrastructures by considering international complementary networks as an important criterion for the take-up in the ESFRI roadmap. Synergies can be enhanced by coordinating the RIs' research plans and priorities as part of joint programming initiatives and e.g. ETPs.

5. *The European eco-industries would benefit from closer ties with research institutions; involvement of SMEs is problematic and countries still 'protect' national environmental monitoring data from wider use.*

Effective knowledgse sharing…

At the conceptual level there are shared principles for cooperation (although their implementation in practice has still to prove successful). Open and easy access to the public knowledge base is established in theory, and the society appears to be increasingly involved in research agenda setting, but precise figures are lacking.

Judged on the basis of collaboration among environmental research institutions (in FP-projects and publishing), there is certainly an upward trend. At the same time, the exchange of national environmental monitoring data, even for research purposes, remains problematic, although several countries have taken measures to promote the circulation of these data in the publically funded projects (yet mostly at the regional level).

Collaboration with industry remains challenging, and SME participation (of the 'right' SMEs) in both research partnerships and valorisation activities is not yet at a (socially) acceptable and/or desirable level.

Recommendations

In the logic of 'smart specialisation', and as a part of the previously discussed foresight exercises, is also important to **map expertise and strengths on an EU-level, and to try to arrive at logical divisions of expertise development** in the future, in order to effectively tackle the major (societal) challenges.

Carry out a detailed analysis on the reasons why the large numbers of SME support measures do not lead to higher participation rates (e.g. through a number of case studies or again 'round table' discussions on this topic). Is there a need to design specific environmental SME support schemes?

6. *Third country participation in European environmental research has increased over time; however, there are too many uncoordinated actions and agreements.*

A wide opening of the European Research Area to the world…

Environmental challenges are of a global nature. The participation of Third countries (i.e. non-Member States or Associated countries) in FP-projects has increased over time. There are plenty of multilateral and bilateral agreements that address global environmental challenges through different research funding actions at national and EU level. A general challenge in this dimension is to further streamline and

harmonize the bilateral collaboration initiatives (at national level), in line with the overall EU strategy (first steps in this direction undertaken by Strategic Forum for International Cooperation).

ERA is an important instrument towards the realisation of a broader range of socio-economic objectives, like increasing European competitiveness in the worldwide market for environmental products and services. Moreover, well-functioning Single Market policies are in this respect crucial. The EU eco-industries employed about 3.4 million people in 2008, as a result of an annual growth rate of 7.0% (between 2000 and 2008). Based on trade data, we see that the EU is the dominant exporter of environmental goods in all markets (export outside the EU has increased by 44% between 1999 and 2007). This suggests a strong EU position in the worldwide environmental market. In photovoltaics, waste disposal, and air pollution control, Europe has the strongest revealed competitive advantage (RCA), in comparison to its main competitors. This fact is worthy of taking into account when determining future ERA priorities.

Recommendations

Encourage an open, but EU-widely orchestrated, dialogue on environmental issues with Third countries. If not possible on an overall EU-level, groups of countries can be formed that are interested in particular issues. Such strategic dialogue can be greatly facilitated by the implementation of Joint Foresight exercises (including joint impact assessment and monitoring) between leading EU and the Third country environmental research institutions.

0.3 Towards the future

Improving monitoring of the environmental ERA.

Recommendations on future ERA monitoring and data availability

On the way towards developing an effective environmental ERA monitoring framework we suggest that a **limited number of indicators** are used which nonetheless reflect the most important aspects of the ERA's progress in the field of environment. Among the numerous indicators we highlight the following six groups:

- Indicators on ERA-NET activities, such as joint calls, activities with common pot financing, virtual common pots, etc.
- Indicators on mobility of researchers (< and > 3 month stays) in the field of environmental sciences.
- Indicators reflecting activities and investment in environmental Research Infrastructures and their networks.
- Degree of openness of national research institutions and infrastructures to participation of foreign researchers.
- Indicators on knowledge sharing activities reflected in the co-publication, co-patenting and citation statistics.
- The volume and direction of the cross-border R&D funding flows among the EU, Associated and Third countries as an indicator for 'R&D FDI' in the field of environmental research.

In collaboration with Eurostat, it is recommended to **look further into the possibilities of data provision on the level of individual environmental subfields** (disaggregated).

Develop a common classification framework for environmental research fields and environmental technologies, compatible across various European information collection platforms (such as Eurostat, FP, ERAWATCH, etc.).

Many Member States provide fiscal incentives (such as tax credits and exemptions) towards investments and expenditures in environmental research and environmentally friendly technologies. **Collecting these data from the national fiscal authorities will provide a good source of information about private financing of environmental research**. This could be taken up in collaboration with Eurostat.

Concerning the number of non-nationals as staff at universities and research organisations, an important indicator, it is recommended to **develop the conceptual framework (definition) needed and to perform a baseline measurement**.

Risks and challenges.

Future measures and priority actions in the area of environment should take potential 'pitfalls' into account: 1) lack of political commitment, and 2) consequences of the economic downturn.

Risks and challenges…

A first major risk to the further development of ERA in environmental research, but also in other fields, is the lack of a clear and visible political commitment and/or public support at different government authority levels. Political leadership in the implementation of the ERA is essential.

In case of further economic downturn, resources for international environmental R&D funding in many Member States may be (further) cut back. As a result, international joint R&D commitments may be questioned and reprioritised in favour of national programmes and ambitions.

Stimulation of more ERA in the field of environment shall require a number of well considered field-specific actions; however, more general actions will also be needed and alignment with the Innovation Union Flagship Initiative will be essential.

1 EUROPEAN RESEARCH AREA (ERA)

1.1 Characteristics and objectives

Europe is facing a substantial number of major societal challenges related to global competition, transformation to a knowledge and service economy, demographic sustainability, social justice, climate change, secure, sustainable and competitive energy, migratory pressure, and security and safety. [1] Responding to these challenges requires that Europe (the 'Community') takes action[2], and turn itself into a knowledge-based society: a society where the knowledge triangle of research, education and training, and innovation is fully mobilised.

As a follow-up on the strategy outlined in the Treaty of Lisbon, the European Commission (EC) presented a future vision, the 'Europe 2020 - A strategy for smart, sustainable and inclusive growth'[3], which was subsequently adopted by the European Council[4]. The main vision underlying this strategy is to turn Europe's socio-economic development in a direction delivering high levels of employment, productivity and social cohesion. An important pillar of the previous Lisbon strategy[5] and the new 2020 Vision is creating a European Research Area (ERA), "in which researchers, scientific knowledge and technology circulate freely, and encouraging it to become more competitive, including in its industry"[6].

The ERA objective dates back to at least the early 1970s[7] but was launched in its current form in 2000 through the Commission Communication "Towards a European Research Area", and subsequently in 2005 through the EC communication on 'Building the ERA of knowledge for growth'. For a long time, ERA has not been an objective per se, but rather the means to increase Europe's competitive position in order to ensure welfare standards.

In 2007 the ERA concept was put high on the European policy agenda through the publication of the 'ERA Green Paper[8]' and the launch of various related policy initiatives. This was confirmed during the Informal Meeting of Ministers for Competitiveness in 2008 [9] [10]. The European Commission has indicated the Framework Programme to be one of the principal instruments to make the ERA to

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1 European Commission, "Reforming the Budget, Changing Europe" – A Public Consultation Paper in View of the 2008/2009 Budget Review, Communication from the Commission, SEC(2007) 1188 final, Brussels, 12 September 2007.

2 Treaty Establishing the European Community (Consolidated Text), Official Journal C 325 of 24.

3 European Commission, "EUROPE 2020 A strategy for smart, sustainable and inclusive growth", Brussels, 3.3.2010, COM(2010).

4 European Council Conclusions 17 June 2010.

5 Treaty of Lisbon amending the Treaty on European Union and the Treaty establishing the European Community, signed at Lisbon, 13 December 2007, Official Journal C 306 of 50.

6 Ibid. [5], Art. 179.

7 According to Michel André (2006), L'Espace Européen de la Recherche: Historie d'une Idée, In: Journal of European Integration History, Vol. 12, No 2, 2006, pp. 131-150.

8 European Commission (2007), The European Research Area: New Perspectives - Green Paper: 04.04.2007, Luxembourg (+ results public consultation).

9 European Council Conclusions 29 and 30 May 2008.

10 P. Laredo (2008), "Discussing the role of ERA in the Lisbon process, the divers understandings of the ERA and the role of the framework programme in fostering Europeanisation", Background paper for the FP6 expert panel.

become reality. The ERA concept combines a European "internal market" for research, where researchers, technology and knowledge circulate freely, effective European level co-ordination of national and regional research activities, programmes and policies, and initiatives implemented and funded at European level[11]. The importance of realisation of the ERA objectives has been re-emphasized in the recent communication of the EC on the "Innovation Union"[12].

In recent years quite some efforts have been made to capture and map the progress towards the ERA. According to the ERA Green Paper (2007) itself, some progress has been achieved since the concept was endorsed at the Lisbon European Council in 2000. However, there is still much to go further, and much 'ground work' remains to be done to build ERA and to overcome the fragmentation of the European public research base. Among other factors (like cultural differences, growth disparities and the gap between research and industry), fragmentation plays an important role and even prevents Europe from fulfilling and utilising its full research and innovation potential, this at a huge cost to Europeans as taxpayers, consumers, and citizens. As a result, we can observe the following:

- Researchers still see career opportunities curtailed by legal and practical barriers hampering their mobility across institutions, sectors and countries.
- Businesses often find it difficult to cooperate and enter into partnerships with research institutions in Europe, particularly across countries.
- Several national and regional research funding instruments (programmes, infrastructures, core funding of research institutions) remains largely uncoordinated. This leads to dispersion of resources, likely unnecessary duplication, and unrealised benefits from potential spillovers, and failure to play the global role that Europe's R&D capability would otherwise allow, notably in addressing major global challenges.
- Reforms undertaken at national level often lack a true European perspective and transnational coherence.

1.2 Dimensions of the European Research Area

The concept of ERA is quite broad and heterogeneous and includes many different dimensions and elements. Even today there is no real consensus on the exact interpretation of the various objectives and associated results. A common understanding is therefore challenging. The various dimensions of the ERA[13] as a basis for further operationalisation and specification are presented below.

Dimension 1: Well-coordinated research programmes and priorities.

In a true ERA there is joint programming, implementation and evaluation of public research investments at European level on issues that go beyond the capacities of individual countries. Common priorities are identified through joint

[11] European Commission, "2020 Vision for the European Research Area".

[12] European Commission, "Europe 2020 Flagship Initiative – Innovation Union, SEC(2010) 1161 final, Brussels, 6 October 2010.

[13] Ibid. [8]

foresight, involving the scientific community, society and industry, and jointly decided and acted upon. In these and other areas, national and regional research programmes should offer confidence that the main principles governing applications for research funding are comparable across the EU and the highest level of quality is ensured. They should together constitute a simple, transparent and coherent system of research funding based on various public sources (national, regional and European) and associated with private sources (including philanthropy and civil society organisations).

Dimension 2: An adequate flow of competent researchers.

In a true ERA there is a single labour market with attractive working conditions for both men and women, involving notably the absence of financial or administrative obstacles to trans-national mobility. There is a full opening of academic research positions and national research programmes across Europe, with a strong drive to recruit researchers internationally, and easy movement between disciplines and between the public and private sectors – such mobility becoming a standard feature of a successful research career.

Dimension 3: Excellent research institutions.

In a true ERA, one finds diversified research institutions across the EU embedded in the social and economic life of their home countries, while competing and cooperating across Europe and beyond. They should be able to interact routinely with the world of business as well as to engage in durable public/private partnerships. Such partnerships should be at the core of specialised – mostly interdisciplinary – 'clusters' which would attract a critical mass of human and financial resources from all over the world. The European Research Area should thus progressively structure itself along the lines of a powerful web of research and innovation clusters. Their reach should be amplified through 'virtual research communities' created by pooling and integrating activities and resources from different locations in Europe and beyond, facilitated by powerful computing and communication tools. Increasingly, clusters should form and expand through such virtual integration rather than geographical concentration.

Dimension 4: World-class research infrastructures.

In a true ERA the major infrastructures should be built and exploited in the form of joint European ventures. They should be accessible to research teams from across Europe and the world, with researchers working in Europe having access to international infrastructures and equipment in other parts of the world. These research infrastructures should be integrated, networked and accessed through the concomitant development of new generations of electronic communication infrastructures, both in Europe and globally.

Dimension 5: Effective knowledge sharing.

In a true ERA there will be open and easy access to the public knowledge base, a simple and harmonised regime for Intellectual Property Rights, including a cost-efficient patenting system and shared principles for knowledge transfer and cooperation between public research and industry, innovative communication channels to give the public at large access to scientific knowledge, the means to discuss research agendas and the curiosity to learn more about science.

Dimension 6: A wide opening of the European Research Area to the world.

In a true ERA there is special emphasis put on the participation of neighbouring regions of the EU, as well as on developing multilateral initiatives to address global challenges with EU's partners.

The description of these dimensions makes it easier to understand what ERA is about and which objectives are important and what they should achieve. Below we shall further structure/operationalise these dimensions and underlying elements.

1.3 Promotion of the European Research Area

The promotion of ERA takes place through the development and implementation of various instruments and programmes, and this at various levels (the EU level, the national level and the regional level). In particular, at the EU level, the European Commission has been leading the way by the introduction of new, and the adaptation of existing R&D support schemes.

The Framework Programme, the Structural Funds, the Competitiveness and Innovation Framework Programme and the European Institute for Technology are the main EU-level instruments and support schemes to contribute to the further development of ERA. In particular, when we zoom into the Framework Programme (both under FP6 and FP7), we find four important building blocks (the specific programmes). Under each of these building blocks, several instruments have been designed to support the development of the ERA[14]. For FP7 the corresponding key components are:

- The Cooperation programme fosters collaborative research by transnational consortia of industry and academia. Research is carried out in ten key thematic areas, among others, in energy and environment (including climate change). The programme also includes the new Joint Technology Initiatives. Also, the coordination of non-community research programmes, which aims to bring European national and regional research programmes closer together (e.g. ERA-NET), is also facilitated.

- The Ideas programme supports frontier research on the basis of scientific excellence. Research may be carried out in any area of science and there is no obligation for cross-border partnerships. The programme is implemented via the European Research Council.

- The People programme provides support for researcher mobility and career development, both inside the European Union and internationally. It is implemented via a set of Marie Curie actions.

- The Capacities programme strengthens the research capacities that Europe needs to become a knowledge-economy. It covers activities such as research infrastructures, research for the benefit of SMEs, Regions of Knowledge, research potential, science in society, and international cooperation.

In addition, the FP-type of support programmes, there are also several broader policy initiatives that aim to facilitate and boost the further development of the ERA, like the European Partnership for Researchers, Open Method of Coordination, Joint Programming, the ESFRI Roadmap on infrastructure planning and strategic outlook, initiatives related to Open Access, the Strategic Framework for International Collaboration in S&T, etc. The majority of these EU policy instruments have been analysed in underlying study in order to map and understand their effect on the progress of ERA in the field of environmental sciences. Furthermore, as ERA is promoted at the national level (e.g. through the national R&D support schemes and measures as registered in the ERAWATCH database[15], the NETWATCH database[16], and through the National Reform

[14] http://ec.europa.eu/research/era/instruments/instruments/european_level_instruments_en.htm

[15] http://cordis.europa.eu/erawatch/

Programmes under Lisbon and the future 2020 strategy) and at the regional level, underlying study also looks into a selection of policy measures initiated and implemented at these levels.

[16] http://netwatch.jrc.ec.europa.eu/nw/

2 METHODOLOGICAL BACKGROUND

2.1 Study objectives and methodology

The six ERA dimensions presented above are not sector-specific, but it is expected that the effects of research policies along each of these dimensions will differ across research sectors and, consequently, that threats, opportunities and actions should be analysed at this sectoral level as well.

The concept of ERA entails the idea of building one strong European knowledge society that reflects and responds to the reality of globalization of research and emergence of new scientific and technological powers. In this respect, the domain of environmental research is an important sector for which to analyse the European policy impacts. Environmental research is an area of great and growing importance at global level. It consists of many sub-domains in which the ERA aims to excel. Within this context, the Directorate General for Research requested for an ex-post impact assessment of European policy on the development of the ERA in the field of Environmental research, i.e. an assessment of the impact of EU and national policies on ERA progress in the field of Environmental research (see Annex 1 for the Terms of Reference of this study).

The overall *strategic objective* of the study is:

> *To promote the European Research Area (ERA) in the field of environmental research through a thorough knowledge base and assessment of progress made and challenges ahead.*

This strategic objective translates into the following *operational objectives*:

- The identification of the barriers causing weaknesses in the sector.
- The identification of the characteristics contributing to success.
- The identification of the trends to assess progress or regress.
- The identification of the geographical disparities.
- The identification of the actions to improve the ERA dimension in the field of Environment.

In order to fulfil these objectives a multidimensional study design has been setup, including multiple and iterative tasks and activities. A first important step has been the development of a measurement framework guiding the data collection and analysis efforts. Data used stem from existing sources (like FP participation data, Eurostat and OECD data, national Member State level data[17], Erawatch and Trendchart data, ESFRI data, NETWATCH data, etc.) and newly developed sources (like publication and patent data). On a country by country basis we collected specific data that we have presented to Member State representatives

[17] Throughout this report, 'Member States' includes the EU-27 Member States and the Associated Countries having participated in the 6th Framework Programme (Croatia, Iceland, Norway, Switzerland, and Turkey.

(i.e. members of the FP7 Environment configuration of the Programme Committee) in the form of country fiches.

It is important to mention that several of the Member State representatives experienced difficulties in validating the collected national/regional information and data, although interaction with most of them has proved to be very helpful in pointing out key policy documents and recent environmental research developments in their respective countries. The reason for this was the lack of access to the relevant databases, like publication and/or patent output databases, FP-participation databases and in some instances EUROSTAT databases. In total, we received feedback from 15 Member States. It should be mentioned that the inventory of national R&D support measures relevant to environmental sciences (as taken from the ERAWATCH database) received a lot of criticism, and this mainly regarding the degree of completeness and accuracy of the collected information (e.g. budget information on specific research programmes). As a consequence, the data and information collected and analysed is not exhaustive, and should be considered at this stage work in progress, mainly for internal Commission use.

A last methodological building block has been the setup and implementation of an explorative web-based survey (among experts proposed to us by the Environmental Programme Committee members, and experts of the LIFE+ programme committee). The objective of this survey was to collect opinions and complementary insights on the progress of the ERA in environmental sciences (and in particular subfields). We received input from experts from Austria, Norway, France, Spain, Switzerland, Latvia, Finland, Estonia, United Kingdom, and Hungary (n=41 opinions). With a subset of respondents, we carried out a telephone follow-up interview.

2.2 The ERA 'logic'

The heterogeneity of ERA as a concept creates a number of methodological challenges. In line with the previously described dimensions, we have developed a 'hierarchy of objectives'[18] in order to systematically measure progress towards ERA in the field of environmental sciences. The ERA Green Paper and the ERA Vision 2020 have been the major background documents for developing this hierarchy.

[18] The hierarchy of objectives is a method that helps to analyse and to communicate the objectives of a programme or other policy intervention. It organizes these objectives into different levels (strategic objectives, sub-objectives, activity-related objectives and horizontal objectives) in the form of a hierarchy or a tree, thus showing the logical links between the various levels.

Subsequently, on the basis of this hierarchy we designed the data collection and analysis strategy. In this respect, we build on the results of the expert group on ERA indicators and ERA monitoring[19] that developed a monitoring framework based on the definition of the ERA setup by Governments in the ERA Vision 2020.

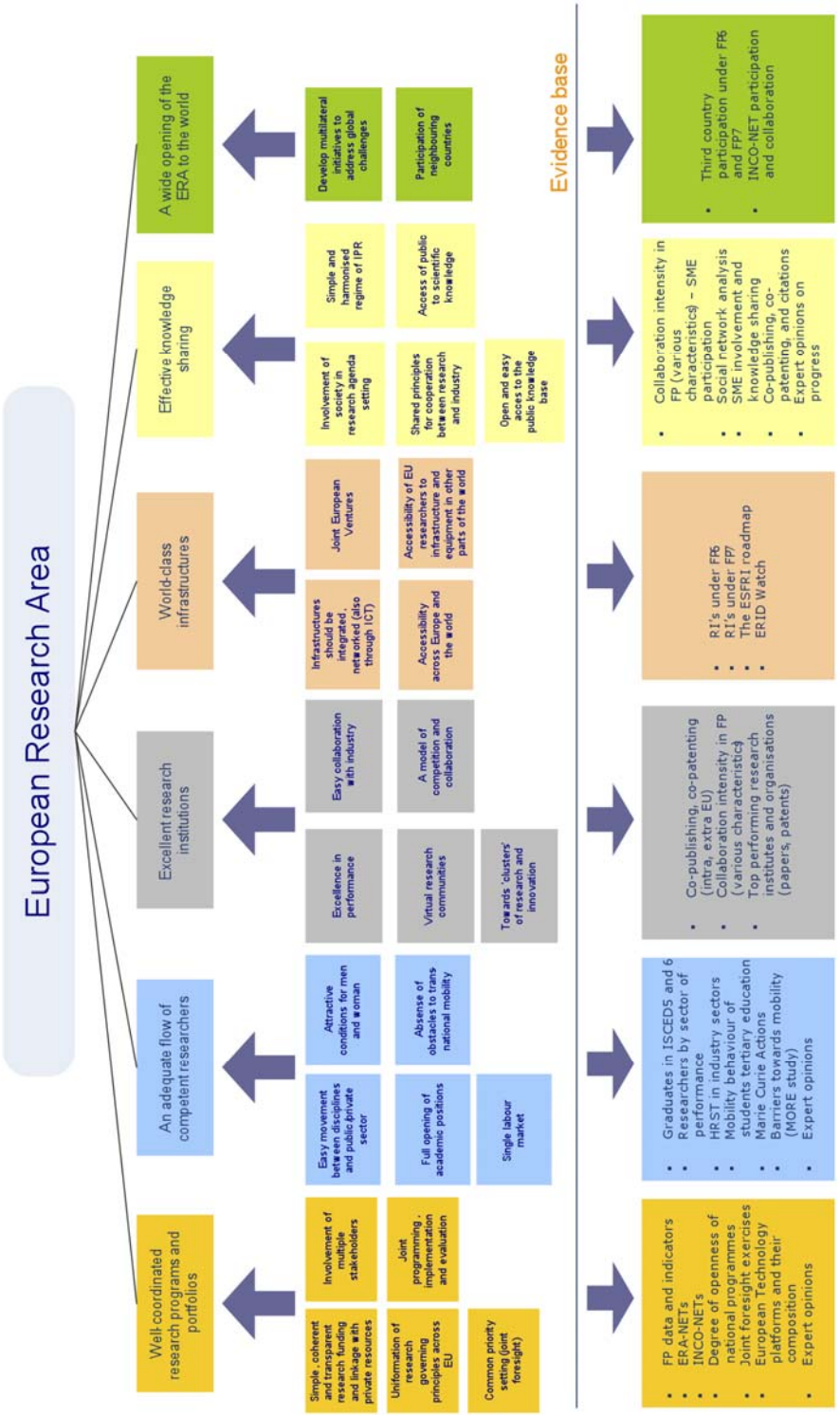
Below we present the hierarchy of objectives and sub-objectives. As we can see there are different objectives and ambitions mentioned under each dimension. Each of these objectives stands for a particular aspect of the future ERA-vision, and in turn contributes to the realisation of a higher level objective. For example, in relation to the dimension 'Effective knowledge sharing', the sub-objective 'Access of the public to scientific knowledge' is relevant for the achievement of more knowledge sharing, albeit between the scientific community and the broader public. Other sub-objectives stand for knowledge exchange between industry and academia.

Although the figure suggests a rather linear interrelation, this is not the case at all. Several objectives relate to and influence more than one ERA-dimension. A good example is barriers towards mobility, which does not only touches upon the dimension 'Adequate flow of competent researchers' but also on 'Effective knowledge sharing': if indeed researchers from the public sector are hampered to move to the private sector, than this will also affect the cooperation possibilities between industry and academia. This makes the analysis of progress towards ERA, and the interpretation of the collected evidence challenging as well.

The hierarchy also shows the types of data and indicators that have been collected in order to assess the impact of national and EU policies on ERA progress expressed in the indicators for progress or regress as we will discuss in the subsequent section. This overview has been preceded by a feasibility analysis of data availability and/or development. One of the conclusions is that although a lot of data is available, there is a lack of data specifically for the field of environmental sciences.

[19] Report of the Expert Group (2009) "ERA Indicators and ERA Monitoring", Executive Summary, Chaired by Rémi Barré

Figure 1: Hierarchy of objectives – ERA



2.3 Appreciation of 'progress'

Progress literally means to 'advance' or to 'move towards a goal'. This is what we have investigated in underlying study: progress towards ERA in environmental sciences and the extent to which this can be linked to the EU and/or Member State policy frameworks.

More precisely, we have analysed progress towards the ERA ambitions since the year 2000, the year of endorsement of the concept by the European Council. Moreover, we compared, to the extent possible, progress during FP6 to progress and the transition towards FP7. The perspective taken in this study was mainly 'inward' looking, meaning that we considered the indications of progress inside the field of environmental sciences. Where possible and applicable, we compared the progress in the environmental field to progress realised in other areas, and mainly the field of Agriculture and Food. Progress could not be captured by one single indicator but was analysed through various data sources and 'proxy' indicators.

In the appreciation of progress, we have first of all looked for indications at the level of the sub-objectives (the second layer in the above presented figure). Subsequently, these findings where grouped/combined in order to make statements about progress on the scale of the entire dimension. This is an important detail, as there might well be progress on single sub-objectives but hardly any progress at the level of entire ERA-dimensions.

2.4 Challenges and limitations

This is the first study aiming to systematically analyse progress towards ERA in one single scientific field, and as such it should be considered as a pilot study. Several challenges were anticipated at the start, but other challenges appeared during the completion of the study. We present the main challenges and limitations below as they may benefit future research in this area (some of them have already been addressed before).

i. *Heterogeneity of the environmental subfields and the lack of tailored data to study progress or regress in detail, as also pointed out by other researchers*[20]*.*

   In more detail, the ten environmental subfields have proved to be so diverse that it was impossible, within the frame of underlying study, to investigate ERA progress in each of these specific subfields. Another factor that contributed to this was also the lack of disaggregated data and statistics, i.e. data at the level of particular subfields. As a result, our results are mainly situated at global level and the level of progress of ERA in environmental sciences.

ii. *The complexity of dealing with different governance levels in determining the impact of 'policies' on progress towards ERA.*

   The so-called 'attribution problem', is a well-know problem when it comes to isolating the effects of particular policy interventions. In this study we have been strongly confronted with this problem. ERA-related initiatives are embraced and implemented at different levels of governance (EU, national and regional). In view of this complexity, and also in view of the wide scope of underlying study, a generalization of 'impact' proved to be the best possible result.

[20] See also: Nauwelaers, C. and R. Wintjes (2009), "Monitoring progress towards ERA", Erawatch report

iii. *The lack of conceptual clarity about some of the notions underpinning the ERA-construction (e.g. 'fragmentation', 'advantages of scale and scope', 'competition vs. coordination', etc.).*

In hindsight, the lack of conceptual clarity caused several difficulties with respect to data collection, but also with respect to the interpretation of findings. It became clear that the stakeholders involved, had a different understanding of what ERA is about. Again, this resulted in rather general findings and conclusions. In view of the increasing importance of ERA and future ERA monitoring, more emphasis should be put on the elaboration of the Logical Framework behind ERA.

iv. *Low quality of several data sources (for example the Erawatch database), especially when disaggregating the data geographically and/or thematically.*

Although in general, the quality of the collected data is acceptable (especially of the newly developed data), a serious problem was encountered with respect to the database/registry on national R&D support programmes (ERAWATCH). Data on national support schemes, like R&D programmes, use of infrastructure, openness towards foreign researchers, mobility etc. have proven to be incomplete and often incorrect. Despite the effort of the Member State representatives to complement and correct this information, it is difficult to claim an exhaustive and fully accurate picture of national efforts towards the realisation of ERA in environmental sciences has been achieved. What we thus present in this report in terms of national efforts towards the ERA should be considered as illustrations rather then the full picture.

v. *Difficulties (as described above) associated with the validation of country specific information by Member State representatives.*

As mentioned before, country specific data and information were processed in so-called 'country fiches' and submitted to national representatives for further validation. In total, 15 countries responded and pointed out to the difficulties that they had faced during this validation process (lack of access to specific databases was one of the main difficulties). For future studies, validity checks need to be organised in another way e.g. through the involvement of national data/statistical experts. The consequence is that the evidence base collected by the study team could only partially be validated (externally). This should be kept in mind when using/citing country specific data.

3 ENVIRONMENTAL POLICY CONTEXT AND SUPPORT

3.1 Introduction

The "Environment" ERA exhibits clear links to other EU policy areas as well as the corresponding policies and programmes at the national level. Some of the most relevant related policies include the 6th Environmental Action Programme (including LIFE+), the Action Plan for Biodiversity, the EU Sustainable Development Strategy, the Environmental Technologies Action Plan, Environment and Health Action Plan as well as the European Climate Change Programme and corresponding international climate change agreements.

In this chapter we subsequently present and discuss the EU environmental policy context and the EU support for environmental research.

3.2 EU environmental policy context

The overall purpose of the European Research Area in the field of environmental research is to promote progress towards the general goals outlined above for all environment related fields, including climate change, natural hazards, environmental health, natural resource management, biodiversity, marine environment, land and urban management, environmental technologies, earth observation, as well as the tools for sustainable development. In order for the ERA to reach its full potential it is essential that adequate EU-wide and national policies and political leadership exist to foster the ERA goals.

1. The **6th Environmental Action Programme** (Decision No 1600/2002/EC) provides the foundation for **LIFE+**, with Article 1 of the LIFE+ Regulation. Over the last thirty years, the European Union has been building a comprehensive legislative framework to guide environmental protection in its Member States and beyond. This process has always been directed by strategic Environmental Action Programmes. The current, 6th Environmental Action Programme established the framework for environment policy for the period 2002 to 2012. The four key environmental priorities and focus issues of the 6th EAP are: Climate Change, Nature and Biodiversity, Health and the Quality of Life, and Natural Resources and Waste. With these themes very similar to those of the environmental research priorities, the 6th EAP aims for environmental protection requirements to be fully integrated into all EU policies and actions. In addition, it recognises that policies must be based on sound science, economic assessment of cost-effectiveness, and the transparent partnership of all the major stakeholders.

2. In May 2006, the European Commission unveiled a new **action plan for biodiversity** (*'Halting the Loss of Biodiversity by 2010 – and Beyond' (COM (2006) 216 final)* aiming primarily at clarifying responsibilities for the implementation of existing legislation, particularly the 6th EAP. One of the priority areas identified by the Action Plan is widening the knowledge base by strengthening the European Research Area.

3. The 6th EAP represents the environmental dimension of the EU's overall **Sustainable Development Strategy** (EU SDS)[21]. In addition to the environmental pillar, the EU SDS is founded on additional social and economic dimensions. Sustainable development has been a fundamental objective of the EU since 1997, as included in Article 2 of the EU Treaty. Sustainable development underpins all EU policies and actions as cross cutting theme. As such, the EU SDS plays an important role in shaping environmental research objectives and priorities and its interactions with other global EU priorities, such as competitiveness, growth and jobs.

4. The **EU Environmental Technologies Action Plan** (ETAP)[22] builds the cornerstone of the EU's commitment to make eco-innovation an everyday reality throughout Europe. An integral part of the ETAP is getting from research to markets. This translates into an Environment and Health Action Plan which focuses on an increase in research.

5. An **EU energy and climate change package**[23] was approved in December 2008. In March 2007, EU leaders committed the EU to cutting its greenhouse gas emissions by 30% of 1990 levels by 2020 provided that other developed countries commit to making comparable reductions under a global agreement. In addition, to start transforming Europe into a highly energy-efficient, low-carbon economy, they committed to cutting emissions by at least 20% independently of what other countries decide to do. To underpin these commitments, EU leaders set three key targets to be met by 2020:

   (1) Cutting greenhouse gases by 20% (30% if international agreement is reached)

   (2) Reducing energy consumption by 20% through increased energy efficiency

   (3) Meeting 20% of the energy needs from renewable sources

3.3 Support for environmental research

3.3.1 Support for environmental research in EU and associated countries

EU and nationally funded environmental research aims at achieving the aforementioned environmental policy objectives. The recent ex-post impact assessment of the FP6 sub-priority "Global change and ecosystems",[24] for instance, concluded that EU research is leading in several environmental areas and that this scientific leadership goes hand in hand with the political ambition of the EU in these areas. EU environmental research contributes to the knowledge base and the development of methods and tools for environmental related policy.

[21] European Commission (2009), "Mainstreaming sustainable development into EU policies : 2009 Review of the European Union Strategy for Sustainable Development", Communication from the Commission.

[22] European Commission (2004), "Stimulating Technologies for Sustainable Development: An Environmental Technologies Action Plan for the European Union", Communication from the Commission.

[23] European Commission (2010), "Analysis of options to move beyond 20% greenhouse gas emission reductions and assessing the risk of carbon leakage," Communication from the Commission.

[24] European Commission, Ex-post Impact Assessment FP6 Sub-priority "Global Change and Ecosystems", Luxembourg: Office for Official Publications of the European Communities, 2009.

We shall first elaborate on the role played by thee Framework Programmes in the support of environmental research, followed by a number of support measures at the level of individual ‘ERA countries’.

EU Framework Programmes

The Framework Programmes have included environmental issues since the 1980s but the environmental research programme gained substantial momentum from the 1990s onwards [25]. FP4 (1994-1998) included an "Environment and Climate Programme" supporting RTD projects and networks of excellence in four areas: (1) "Research into the natural environment, environmental quality and global change"; (2) "Environmental technologies"; (3) "Space technology applied to Earth observation and environmental research"; (4) "Human dimensions of environmental change".

The priorities for environmental research under FPs 5, 6 and 7 are presented below. EU funded environmental research objectives have evolved quite significantly over time. It is difficult to compare budgets for environmental research across FPs as the structure of the FPs and the precise scope and content of each thematic priority have changed from one FP to the next. Under FP6, some 851 million euro (own calculations) was allocated to the thematic priority "Global change and ecosystems", while under FP7, some 1.9 billion euro has been allocated to the thematic priority "Environment (including climate change)".

The priorities set under the umbrella of environmental research are presented in the paragraphs below.

- **Climate change** and its impacts has become one of the greatest environmental, social and economic threats the world is facing in the 21st century. In terms of research, the global dimension of the problem requires improved understanding of the underlying processes, impacts and corresponding mitigation and adaptation options. Currently, a number of international collaborative research efforts have been established, for which Europe has played and continues to play a leading role. Climate change research has been present in the EU's Framework Programmes since the 1980s, focusing mainly on the stratosphere (ozone layer). FP5 supported projects in the action "Global Change, Climate and Biodiversity", while FP6 backed many integrated projects on climate change, with research areas ranging from atmospheric pollutants to the prediction of climate change and its impacts. For FP7 (2007-2013), climate related research is dealt with across various themes, including 'Environment (including Climate Change)', 'Energy' and 'Food, Agriculture, Fisheries and Biotechnology'.

- Environmental factors can have negative impacts on **human health**. In recent years worrying trends, such as increasing cancer rates, reduced fertility rates, and an increase in allergies and asthma have reinforced this concern. A specific key action 'Environment and health' was first introduced under FP5. During the 1990s this action initiated more than 90 transnational research projects. FP6 further increased research efforts with an annual funding of around €50 million a year for the 2002-2006 period. In recent years, one of the main policy drivers for research has been the European Environment and Health Action Plan (EHAP), adopted in 2004. Under FP7, the area of environment and health has become more integrated into environmental research as one of the main sub-activities of the "Environment (including climate change)" theme.

- While **natural hazards** have always existed, their frequency and intensity has increased over the past decades. Disaster risk reduction has been a world challenge since the UN International Decade for Natural Disasters Reduction (1990–2000) and

[25] Ibid. [24]

its follow-up Hyogo Action Plan (2005–15). Historically, the EU has supported multi-national and interdisciplinary research in the field of natural hazards since the late 1980s addressing mainly climate- and geological-related hazards such as floods, landslides, avalanches, forest fires, earthquakes and volcanic eruptions. Under FP6, the focus has changed to a more holistic approach in which 'hazard-vulnerability-risk' assessment were addressed in an integrated manner with the aim of mitigating the environmental, social and economic effects of natural disasters. As a sub-activity of the 'Climate change, pollution and risks' activity in FP7, natural hazards research consider a robust and comprehensive framework.

- Similar to Europe's natural resources, the region's **biodiversity** is also suffering from the various pressures. The EU has committed to halting biodiversity loss. Under FP7, research is directed towards assessing and forecasting changes in biodiversity and understanding the dynamics of ecosystems, particularly marine ecosystems. Furthermore, the relationships with society and the economy are being investigated to understand what options are available to mitigate any harmful effects and to assess possible impacts on human health and society.

- Due to the fact that society and the economy is based to a large extent on the exploitation of natural resources, policy making and research have been trying to learn more about and take into account how to better **manage natural resources** in a sustainable manner. By the time FP6 started, research focus moved from single topic cluster-based research to larger scale integrated projects with holistic approaches and multi-disciplinary teams covering the complexity of interlinkages between various natural resources. Currently, sustainable management of resources is one of the four main activities of the FP7 work programme.

- The **marine environment** is home to an abundant range of biodiversity. In 2007, the European Strategy Forum for Research Infrastructure has made recommendations for integrating marine sciences in Europe and for strengthening marine research infrastructure. "Sustainable management of marine environments" is an important sub-activity of the research theme on the environment (including climate change) under FP7. It focuses on improving our understanding of the impacts of human activities on the ocean and seas and on marine resources.

- **Environmental technologies** have been chosen as one of Europe's key tools for leading the green revolution and moving towards a low-carbon economy. The area of protection, conservation and enhancement of **cultural heritage** is also considered as an integral part of this domain. To this end, research needs to focus on reinforcing the links between research institutions and industry. The creation of the European technology platforms, that form public-private partnerships on a specific research topic, for example in water research or in photovoltaics, have been helping this process. Yet another important dimension is the fact that environmental and cultural heritage preservation technologies need to be developed and promoted in the developing world. The EU is committed to supporting eco-technologies in the developing countries and promoting foreign (green) investment. Environmental and cultural heritage preservation technologies research in FP7 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 2002 World Summit on Sustainable Development in Johannesburg, South Africa, highlighted the urgent need for coordinated observations relating to the state of the Earth. Today, research in **earth observation** is seeking to better integrate land- and sea-based sensor networks with space-based platforms so as to enable observation and comparison on a global scale. Such integration would allow for better results, giving policy-makers more accurate information for environmental decision-making.

Europe has played a leading role in the advancement of earth observation research, technology development and related environmental applications. Currently, earth observation projects are increasingly being integrated into the Global Earth Observation System of Systems (GEOSS), which brings together 71 partner countries from around the world as well as the European Commission. In FP7, four blocks toward the establishment of GEOSS are addressed and emphasized.

- Finally, **sustainable development** has been a core policy and research objective of the European Union. The EU's Sustainable Development Strategy (SDS, Article 11) reaffirms the importance of assessing the impact of a policy, where its social, environmental and economic dimensions are evaluated in a balanced way, taking into account the external dimension and cost of inaction. A range of practical tools to support informed decision-making was developed under FP5 and FP6. They include modelling and simulation software, accounting frameworks and codes of practice, as well as impact assessment, performance monitoring and external cost estimation tools. In the context of FP6, projects examining the development and use of sustainable development indicators were funded.

R&D support programmes at the national level

At the national levels, we find a large (even larger) number of environmental R&D support programmes, knowing that the overall FP cycle spending is only a small fraction of the combined R&D spending of the EU and associated countries. As an illustration, a number of most prominent examples of R&D programmes in different countries, specifically designed to strengthen R&D in environmental sciences is presented below.

In **Austria**, there are large investments made in 'Technologies for Sustainable Development' (overall budget of over 64 million euro), as well as the 'Earth System Sciences Initiative' – Austrian Academy of Sciences, GBA, ZAMG and BMWF (budget of 17.5 million euro). Furthermore, there is the 'PFEIL10' programme for Research and Development, managed by the Ministry of Agriculture, Forestry, Environment and Water Management (budget over 94 million euro). This programme aims at contributing to a high quality of life in Austria with regard to the preservation and responsible use of natural resources, soil, water, air, energy and biodiversity.

In **Belgium**, there is/was (ending 2009) the large 'Science for Sustainable Development' (SSD) – Federal research programme (more than 61 million euro). This programme focuses on research in the domains of Health and Environment: health risks relating to biological, chemical, physical exposures, the work environment; Climate (including Antarctica): understanding the climate system, analysing the impact, adaptation and vulnerability (particularly in Belgium), and supporting the preparation and evaluation of mitigating measures concerning climate changes; Biodiversity: (including Antarctica and the North Sea); Atmosphere and terrestrial and marine ecosystems (including the North Sea). Another interesting support measure is the 'Competence Pole MIP' which targets and stimulates the development of environmental technologies.

For **Denmark**, we point to the 'Strategic research programme for environmentally sustainable energy and energy production' (budget of about 60 million euro), and the Energy Technology, Development and Demonstration Programme - EUDP (with a budget of more than 157 million euro). The main objective of the EUDP is to ensure the development and demonstration of new energy technologies, which can reduce dependency on fossil energy, and which can contribute to minimising the CO2 burden and the environmental impact of energy consumption.

In **Finland**, the following two programmes caught the attention: 1) 'Sustainable community' (budget over 100 million euro), and 2) 'Water Programme' (budget 91

million euro). The first focuses among other on the significant improvement in the energy efficiency of buildings and communities and the promotion of adopting renewable energy sources. The second promotes operations that focus on domestic water supply, waste water and industrial water. The key themes of the programme are water sector reform, networking and internationalisation.

France has several R&D support programmes dedicated to environmental sciences. Two important ones are: 1) 'Management of ecosystems and resources' (budget well over 1.2 billion euro), and 2) the 'Risks and Pollution' programme (over 290 million euro), both managed by the Ministry of Research and Higher Education.

Equally, **Germany** also has implemented a large number of environmental R&D support programmes, like the 'Climate2 - Research for Climate Protection and Protection from Climate Impacts' (budget over 35 million euro) and the 'Next Generation Solar Energy Technology programme' (budget over 40 million euro).

In **Norway**, we see the 'AQUACULTURE - An industry in growth' programme (budget over 36 million euro) - focusing on developing a foundation of knowledge for research-based advice in the field of aquaculture. Furthermore, there is the 'NORKLIMA - Climate change and impacts in Norway' (budget over 53 million euro), that focuses on the climate system; climate trends in the past, present and future; direct and indirect impacts of climate change on the natural environment and society.

Ireland has the large 'Science, Technology, Research and Innovation for the Environment' (STRIVE) programme (budget well over 100 million euro). The purpose of the programme is to protect and improve the natural environment by addressing key environmental management issues through the provision of world-class scientific knowledge.

In **Israel** we have identified two important dedicated R&D support programmes: 1) 'Nataf - Water improvement by nano technologies', and 2) 'Katamon' (over 400 million euro). Both focus on conduction of (feasibility) studies of innovative ideas for water production, treatment or saving.

The majority of these measures have been inspired by local/national needs, and the country-specific cultural/historical background. Most of these measures certainly strengthen the knowledge body and innovation performance of the European eco-industries, but at the same time they are not (fully) open to foreign researchers.

3.3.2 Beyond the EU and associated countries

Also outside the EU and/or associated countries, there is significant attention for research as means to achieve environmental policy objectives. Several examples follow below.

Environmental R&D is a priority area also in the **United States**. Federal agencies in the field of environmental policy provide funding for R&D of about 2 billion dollars per year, which is 1.6% of total federal R&D spending (2006 figures). Environmental R&D programmes are also covered as part of sectoral R&D policies. Besides the numerous R&D funding possibilities/programmes offered by the National Science Foundation (NSF) in environmental sciences (under the programme area of Environmental Research & Education), the Department of Commerce has identified a number of environmental R&D priority areas. Among these areas are 'Climate Change' and 'Hydrogen Fuel'.

The Climate Change Science Program is focused on improving decision-making on climate change science issues. This programme involves 13 departments and agencies and has a 2006 R&D budget of €1.7 billion, with the NASA providing over 60% of the funding. The 'Hydrogen Fuel Initiative' (HFI) seeks to support R&D aimed at developing and improving technologies for producing, distributing, and using hydrogen to power automobiles. The Department of Energy is the lead agency in this effort, with €210 million budgeted for HFI R&D in 2006.

The US National Center for Environmental Research[26] (NCER) is one of seven research organizations that comprise EPA's (Environmental Protection Agency) Office of Research and Development (ORD). NCER and ORD mirror the National Academy of Sciences' risk assessment paradigm by focusing research on: Exposure, Effects, Risk Assessment, and Risk Management. NCER's Science to Achieve Results or STAR program funds research grants and graduate fellowships in numerous environmental science and engineering disciplines through a competitive solicitation process and independent peer review. In addition, through this same competitive process, NCER periodically establishes large research centres in specific areas of national concern. At present, these centres focus on children's health, particulate matter, computational toxicology, and biological threats to homeland security. Research areas of previous centres have included hazardous substances, estuarine and coastal ecosystems, and environmental statistics.

One of NCER's highest priorities is ensuring the availability of adequate and well trained scientific workforce that can address tomorrow's complex environmental issues. To respond to this need, NCER supports several fellowship programs focusing on current and future environmental professionals. STAR research is funded through Requests for Applications (RFAs), prepared in cooperation with other parts of the Agency and concentrate on areas of special significance to the EPA mission. STAR RFAs have focused on air toxics, health effects of particulate matter, drinking water, water quality, global change, ecosystem assessment and restoration, human health risk assessment, endocrine disrupting chemicals, pollution prevention and new technologies, children's environmental health, economics and decision sciences, computational toxicology, nanotechnology, and biomarkers.

NCER receives approximately 2000-2500 proposals every year for its STAR research and graduate fellowship programs. Each year, STAR awards about 150 research grants and 125 graduate fellowships. NCER also makes awards under joint RFAs with partnering agencies. These grants and fellowships have been awarded to universities and non-profit research institutions in all 50 states, Guam, Puerto Rico, and the District of Columbia.

NCER also supports the development of innovative environmental technologies and products through its Small Business Innovation Research program (SBIR). Small firms are eligible to apply for annual solicitations focused in areas of the Agency's interest. SBIR solicitations, awards, and research summaries are posted on the NCER internet site. These SBIR solicitations, like the STAR grants, are targeted towards areas of particular importance to EPA's mission. In addition to STAR fellowships, NCER operates the Greater Research Opportunities (GRO) program which offers Graduate Fellowships for master's and doctoral level students and undergraduate fellowships in environmentally related fields of study. NCER also participates in the following other fellowship programs: the American Association for the Advancement of Science (AAAS) Science and Engineering Fellows Program; the Association of Schools of Public Health (ASPH) Fellows Program; and the EPA Marshall Scholarship Program.

[26] Source: http://www.epa.gov/ncer/

NCER also operates an undergraduate research grant program called P3. The P3 program was designed to demonstrate the possibilities of innovative, inherently benign, integrated, and interdisciplinary designs that simultaneously benefit people, promote prosperity, and protect and preserve the planet. NCER's P3 Program funds 1 year Phase 1 grants to undergraduate teams to participate in an annual sustainable design competition.

The **Asian** regional research programme on Environmental technology "Improving Air Quality in Asian developing Countries" was performed among the Research Centre for Eco-Environmental Sciences (Chinese Academy of Sciences), Department of Chemical Engineering (India), Department of Environmental Engineering Institute of Technology of Bandung (Indonesia), Manila Observatory (Philippines), and Faculty of Environmental Science (Hanoi University of Science, Vietnam).

The mandate of the Natural Resources Management and Environment Department at Food and Agriculture Organization of the **United Nations** is to provide leadership, technical and policy advice and knowledge towards the sustainable use of the earth's natural resources (land, water, genetic resources and biodiversity); improved responses to global environmental challenges affecting food and agriculture, such as climate change and land degradation; assessment of opportunities and challenges of bio-energy; and strengthened transfer and extension of knowledge required towards these goals. The Division for Sustainable Development (DSD) at the UN department of Economics and Social provides leadership and is an authoritative source of expertise within the United Nations systems on sustainable development. It promotes sustainable development as the substantive secretariat to the UN Commission on Sustainable Development (CSD) and through technical cooperation and capacity building at international, regional and national levels.

4 ERA PROGRESS IN AREAS RELEVANT TO THE ENVIRONMENT

4.1 Introduction

In this chapter we will provide answers to the evaluation questions by combining the findings of the desk research, with the findings from the expert interviews and the extensive data collection and analysis process.

Under each ERA-dimension we first briefly present the key issues central to the respective dimensions. Subsequently, we present selected fact and figures in the context of indications of progress or regress, followed by a discussion of each of the evaluation questions. Each dimension will be concluded by a summarizing overview of strengths, weaknesses, opportunities and threats.

As already discussed in the methodological section, a small scale explorative survey, followed by a limited number of follow-up interviews, was launched among international experts on their appreciation of ERA 'progress' in the area of environmental sciences. Although the response rate (n=41 experts) cannot be considered to be representative, the outcome is interesting when considered in relation to all other findings. The surveyed experts indicated that some progress towards the ERA objectives have been achieved with respect to a wide opening of the ERA to the world (Dimension 6), the development, interconnection and accessibility of world-class research infrastructures (Dimension 4), and the flow of competent researchers (Dimension 2). According to the same group of experts, too little progress was made in relation to effective knowledge sharing (Dimension 5).

These results should be interpreted with great care in view of the limited sample size and the difficulties associated with the concept of 'progress' and the ERA dimensions. We shall see later on to what extend these opinions coincide with the detailed analysis of the facts and figures.

4.2 Dimension 1: Well-coordinated research programmes and priorities

4.2.1 What is it about?

An important ERA-dimension is the coordination of research programs and priorities which implies the following objectives:

1. Simple, coherent and transparent research funding and linkage with private resources.

2. Harmonisation of research governing principles across the EU.

3. Involvement of multiple stakeholders.

4. Common priority setting (joint foresight).

5. Joint programming, implementation and evaluation.

In relation to objectives 1 and 2 the so-called 'opening-up'[27] of national R&D programs is intended to lead to a true EU competitive research environment based on excellence as the main funding criterion. Objectives 3, 4 and 5 are 'process objectives' that refer to the common agreement and decision on research priorities across national borders. This ERA dimension should lead to less fragmentation and duplication of research efforts in Europe.

Each of these aspects is handled below, where we present the results and answers around each of the distinguished research questions.

4.2.2 What does existing literature say about the adequacy of EU and national (and regional where appropriate) environmental research policies to foster ERA?

In the last few years there have been different studies on the progress of the ERA. ERA-related initiatives, mainly driven by the European Commission and the FP-related support measures and programmes, have certainly stimulated debates and considerations, and have created awareness about the potential benefits of ERA (e.g. avoidance of duplication and fragmentation in R&D). Despite the fact that the total progress in general is still not enough[28], significant positive developments have been achieved, largely as a result of the adequacy of EU-level policies (referring to the success of the FP in general and the ERA-NETs, the Technology Platforms, Marie Curie mobility schemes in particular). The impact assessment[29] of the FP6 sub-priority 'Global Change and Ecosystems' points out the progress made with respect to the 'institutionalisation of the ERA'. Participants to (environmental) ERA-NET refer to several benefits and value added[30], like the alignment of national research priorities. Below, we pay further attention to some of the major, so-called, ERA 'structuring' mechanisms.

- The ERA-NETs[31] play an important role in the development of the ERA. ERA-NETs have made it possible for programme owners and managers to come together, learn from each other and develop joint research programmes and joint calls. We consider the ERA-NET scheme as quite successful in stimulating and facilitating cooperation between Member States at both the national and regional levels, as also pointed out by the impact assessment of the ERA-NET scheme under FP6[32]. There is ample evidence that ERA-NETs generated new opportunities for transnational R&D through the alignment and transition of eligibility criteria for funding of non-resident researchers[33].

- European Technology Platforms (ETPs) provide a framework for stakeholders, led by industry, to define research and development priorities. Besides the orientation

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27 'Opening-up' can be interpreted in two ways: 1) countries open up their national research programs to foreign researchers who are willing to move to the country (research is performed 'at home'), and 2) countries open up their national programs to non-domestic researchers but allow research to be conducted abroad in the home countries of the foreign researchers.

28 Ibid. [8]

29 Ibid. [24]

30 Finnish Environment Institute (2009), "Transnational research programmes on environment – Analysis of ERA-Nets' experiences and recommendations for good practices"

31 ERA-NETs are networks of research funding organisations with the aim of promoting the development of jointly coordinated and funded research programs.

32 European Commission (2009), "FP6 ERA-NETs Study – Impact assessment of the ERA-NET scheme under the Sixth Framework Programme", EUR 23909

33 Ibid. [32]

of the framework programme to better meet the needs of industry, ETPs stimulate technological progress in e.g. areas of sustainable development. There are 10 (out of 36) ETPs (e.g. Biofuels, Water Supply and Sanitation Technology Platform, Plants, Photovoltaics, Water*Borne*) active and dedicated to R&D in environmental subfields (many more ETPs, however, focus on R&D areas that influence environmental issues and aspects).

- These 'environmental' platforms represent about 53 research institutions, companies and universities from 17 countries. Countries with strong industrial and scientific capabilities like Germany, France, UK and Spain who are also strongly represented in the boards of these platforms. Many ETPs have so-called national mirror groups, which reflect the views of the Member States on the chosen R&D priorities and provide the opportunity to Member States to align their R&D priorities with the ones identified by the ETPs. Some of the ETPs have advanced into Joint Technological Initiatives (JTIs) thereby contributing to joint programming and joint management of research projects across national boarders.

- Foresight comprises a systematic process of looking ahead in time and identifying R&D challenges and opportunities. Foresight exercises in the area of environmental R&D have been carried out by Denmark, The Netherlands, Spain and the UK[34]. Common foresight exercises where more than one Member State is involved, is not a common phenomenon. Increasingly, however, countries do look over their geographical borders when prioritising.

- A final important 'structuring' EU-initiative is the establishment of Knowledge and Innovation Communities (KICs), directed by the European Institute of Innovation and Technology (EIT). Two out of the three selected KICs relate to environment/climate and energy. The Climate-KIC will initially focus on achieving excellence in four areas: assessing climate change & managing its drivers, transitioning to low-carbon resilient cities, adaptive water management and zero carbon production. The KIC InnoEnergy shall focus on sustainable energy. Both KICs bring together academic, regional and corporate partners.

At the national level environmental research policies are less ERA-oriented, especially from the 'funding perspective'. The barriers in relation to opening-up to foreign-based researchers are still significant. Political resistance and regulatory barriers prohibit funding of foreign based research teams. A large part of the R&D support measures and programmes that we have analysed are 'on paper' open to the participation of foreign researcher as part of national research teams.

At the regional level[35], there is less policy space to develop initiatives towards the ERA. The initiatives seem to be more prevalent at the national level then the regional. The more autonomous regions (with more sophisticated R&D support systems) seem to be more active in working towards the ERA objectives. Little evidence was found that regions were 'opening-up' their regional research programs to foreign participants. There is nevertheless collaboration among regions, especially in tackling local environmental challenges and problems.

[34] Source is the European Foresight Monitoring Network (http://www.foresight-network.eu/)

[35] Erawatch, "Contribution of policies at the regional level to the realisation of the European Research Area"

4.2.3 *What are the strategic priorities for environmental research at EU and national level?*

At the EU level the environmental research priorities are reflected in various initiatives. Under FP6 emphasis was put on greenhouse gas emissions and atmospheric pollutants, water cycle, biodiversity and ecosystems, desertification and natural disasters, sustainable land management, modelling of climate change, and sustainable development concepts and tools. Under FP7 the emphasis lies on climate change, pollution and risks, sustainable management of resources, environmental technologies and earth observation and assessment tools. As a result of how FP-programming takes place (among other through public consultations), one could say that FP by definition reflects national interests and priorities.

The 6th Environmental Action Plan provides the foundation for LIFE+. Over the period 2002-2012, the focus lies on Climate Change, Nature and Biodiversity, Health and the quality of Life, and Natural Resources and Waste. These priorities are in line with the FP research priorities and are also based on national (level of Member States) interests and challenges.

At the national level, countries prioritize largely by focusing on the key 'local' challenges they face. Nevertheless the broad lines in terms of R&D priorities are quite similar. Below we present a few examples of national strategic priorities based on the 2009 Environment Policy Review[36] in order to illustrate the convergence between national and EU priorities.

- **Austria** started the initiative for Biodiversity Research in 2008. Environmental technologies are an important segment of the Austria economy, which lead to a Master Plan for Environmental Technologies.
- In **Belgium** the 2nd Federal Plan on Sustainable Development 2004-2008 (FPSSII) includes a specific action point on 'protecting biodiversity'.
- **Germany** is a leading producer and exporter of environmental goods and services. The German Federal Government identifies energy and resource efficient technologies as a key factor for sustainable development. There is a strong need for developing, supporting and fast market penetration of environmental technologies such as electric mobility. The different forces within Germany are too bundled for funding applied research besides developing superior research and innovation policy strategies.
- The Environmental Protection Agency in **Sweden** decided to launch a new framework programme for game/wildlife research for 2009-2014. The Swedish government shall promote research within energy efficient technologies, transport systems and renewable material, which are all considered important for the environmental challenges of the future.
- In **Denmark**, a Centre for Green Transport was established in February 2009 to promote and implement research in the area of alternative fuel technologies and intelligent transport systems. Moreover, a new climate change research centre was established: the Centre for Regional Change in the Earth System. It is charged with generating knowledge about the climate in the future and providing the municipalities and regions with the latest knowledge on how to tackle current climate change challenges. Among others, priority is put to renewable energy technologies, energy efficiency, carbon capture and storage etc.
- In **France**, priority is put to stop biodiversity loss by 2010 (2004-2010 National Strategy for Biodiversity). In this context 10 sectoral 2009-2010 Action Plans were adopted, in areas like natural heritage, the sea, international negotiations, agriculture,

[36] European Commission (2010), "2009 Environment Policy Review – Part III", Commission Staff Working Document, SEC (2010) 975

urbanism, transport infrastructures, forest and research. The Action Plan for the Sea foresees the adoption of measures to reduce accidental catches during fishing.

- In **Bulgaria**, as a result of the Soil Act of 2007 which aims to prevent soil degradation, inventory and research is carried out to determine the areas of potential and real risks of soil deterioration.
- In **Hungary**, the National Office for Research and Technology allocated about 70 million euro from the Research and Technology Innovation Fund to projects supported under the National Sciences, Technology and Innovation Strategy. A number of innovative environmental projects, such as methane production from livestock farm by-products, have been funded by the Hungarian Research and Technology Innovation Fund. A comprehensive environmental foreign trade programme with a focus on innovation, research and development and technology transfer projects, 'KEXPORT', was launched by the government in 2007. It aims at an efficient transfer of environment-friendly technologies to developing countries.
- In **Ireland**, the government announced a target for 10% of all vehicles in the transport fleet to be powered by electricity by 2020, thus focusing on the promotion of a low-carbon economy.
- In **Italy**, the Italian National Agency for New Technologies, Energy and Sustainable Economic Development (ENEA) will focus on research, innovation technology and advanced services in the field of sustainable economic development and energy including nuclear energy. In 2009, the Agency started developing several strategic projects in areas such as carbon capture technologies, renewable energy sources, and biofuels.

Outside Europe, **China's** National Climate Change Programme (2007) has declared that the strategic goals of China to respond to climate change were to make significant achievement in controlling greenhouse gas emissions, to enhance the capability of continuous adaptation to climate change, to promote climate change related science, technology and R&D to a new level, to remarkably raise public awareness on climate change, and to further strengthen the institutions and mechanisms on climate change[37].

In the **United States**, the Global Change Research Program (USGCRP) coordinates and integrates federal research on changes in the global environment and their implications for society (http://www.globalchange.gov). Led by a team of Principals from each of the USGCRP's 13 participating agencies, the USGCRP engages in a variety of activities aimed to strengthen and strategically direct climate change research in the United States, and improve the flow of that information to policy-makers, federal, state, and local decision-makers, and the public.

Furthermore, at the international level, the World Climate Change Research Programme (WCRP) has developed an Implementation Plan for 2010-2015. To achieve its primary objective, WCRP is organized as a network of core and co-sponsored projects, working groups and cross-cutting initiatives[38]. The current core projects of WCRP are Climate variability and predictability (CLIVAR), Global Energy and Water Cycle Experiment (GEWEX), Stratospheric Processes And their Role in Climate (SPARC), and Climate and Cryosphere (CliC).

[37] http://www.ccchina.gov.cn/WebSite/CCChina/UpFile/File188.pdf

[38] http://www.wmo.int/pages/prog/wcrp/documents/WCRP_IP.pdf

4.2.4 *Are the priorities consistent with those of other national, intergovernmental, European, international programmes? Is there insufficient/excessive coverage?*

Consistency suggests coordination and collaboration in prioritization of research programs. Coordination can be achieved through mechanisms like the ERA-NETs, Joint Programming, Joint Technology Initiative and the Technology Platforms. We should also not forget intergovernmental bilateral and multilateral agreements and initiatives such as COST, EUREKA and EIROForum. By looking at the previously presented environmental research priorities, there indeed seems to be consistency between research priorities at the national and the EU-levels. At the same time it seems that both at EU level and at national levels, the same challenges are being dealt with. Although a much more detailed analysis of similarities would be required in order to draw solid conclusions, it might be useful to further look into the research topics that could best be tackled at EU (FP) level, and those topics and challenges that should be tackled at the national level, e.g. the local challenges.

Compared to the US-priorities in environmental research, the broader topics seem to be rather similar, although the emphasis seems to differ as well (cf. focus on stratospheric process in relation to climate changes, as emphasized under the earlier mentioned U.S. Global Change Research Program). The WHO has recently focused on the interrelation between climate change and human health, an issue that is also present on the EU agenda.

4.2.5 *Are the underpinning funding schemes well coordinated? To what extent are environmental research programmes and funding schemes open to transnational participants?*

Member States have developed and implemented numerous general R&D support programs, besides programmes tailored to the particularities of environmental research. Based on the Erawatch inventory of national R&D support measures, we have identified over 90 R&D support programmes and measures relevant to environmental sub-disciplines and actors. About 50% of these measures are 'open' to non-national researchers from the EU. About 40% is open to researchers from Third countries. Despite the relatively 'open' character of the research programmes and support measures, in reality (and often based on national legislation) the researchers are obliged to be part of national research teams. In result, national R&D funds often stay inside the national 'borders'. The information on the 'openness' of the national R&D support programmes has been drawn from the ERAWATCH database. During the validation process we have received several comments from country representatives on the accuracy of the retrieved information. As a consequence, this information has to be interpreted with care.

Although several of the national R&D support programmes and measures are open to foreign researchers, this only applies to cases where these researchers are part of national research teams. For coordination of EU-funds with the national funds we have to consider the Article 185 (previously known as Article 169) initiatives and the use of joint calls of ERA-NETs. In environmental sciences we have identified 28 relevant ERA-NETs[39] (active and non-active), which equals to almost 25% of all ERA-NETs (under FP6 and 7). Participation intensity of countries in the environmental ERA-NETs coincides with levels of public funding for R&D. France, Germany, UK, Austria and Spain are most active in the environmental ERA-NETs. There have been 8 Joint Calls launched by the environmental ERA-NETs, the fourth highest among all NETs, with an estimated total value of over 100 million euro.

When comparing transnational joint calls with national programs, finding consensus on funding and proposal evaluation criteria in the 'multi-stakeholder' model seemed to be more difficult opposed to consensus on duration and themes, which is often even easier than at the national level[40]. About the funding, most ERA-NETs work with so-called 'virtual common pots' as a result of barriers in funding of non-resident researchers stemming from national regulations. Some environmental ERA-NETs have managed to set up a true common pot or have experimented with it (like BONUS and SKEP ERA-NET). Besides the openness of national funding schemes to transnational participants, another issue of concern is the asynchronous funding cycles, which makes cross-country collaboration (in e.g. international programs) rather challenging.

[39] Specific information on the ERA-NETs was obtained through NETWATCH http://netwatch.jrc.ec.europa.eu/nw/

[40] Ibid. [30]

Important in this respect is also the role of COST that allows for the coordination of nationally-funded research at European level and opens up the European Research Area to cooperation worldwide. Under the domain of Earth System Science and Environmental Management, emphasis is put on science and technology related to improving natural resource management for minimizing environmental degradation. There are several examples of institutional participation from non-COST countries under this domain, although further intensification seems possible. EUREKA provides a platform for international collaboration in innovation. The Energy and Water clusters (ACQUEAU and EUROGIA+)[41] are directly related to the environment. EUREKA is open to transnational, mainly EU organisations and companies, and has one associated country, South Korea.

4.2.6 *What share of national environmental research funding is allocated jointly/through a common pot at European level? What has been the effect of such funding?*

There are several funding schemes as already discussed in the context of Joint Calls: 1) real common pot, 2) virtual common pot, 3) coordinated common pot (mixed mode). The first allows for transnational flow of funds and works well for larger countries. This mode does not guarantee the backflow of the national funds (no 'juste retour'). This has been the preferred mode for ERA-NETs under FP6. In the second model each country funds its own national projects. The latter, a combination, is the more preferred model among ERA-NET participants and is feasible for most of the countries. A recent analysis[42] of 56 joint calls concluded that the majority of the joint calls were implemented with a virtual pot model (64.3%), almost 27% followed a common pot and only 9% implemented a mixed mode funding model. Based on the same analysis, it became clear that around 100 million euro was mobilized by Joint Calls of environmental ERA-NETs (about 60% of this is 'planned' – status 2009). Due to the lack of precise quantitative information, we cannot make a reliable estimation of the share of national environmental research funding allocated through a common pot.

4.2.7 *What is the level of investment in existing and planned public and private EU and national (and regional where appropriate) environmental research programmes and funding schemes?*

Adequate funding levels for environmental R&D are an important building block for the development of the ERA in environmental sciences. Government Budget Appropriations for R&D[43] (GBAORD) provide a good indication of national investments in different socio-economic areas. Two environmental areas were investigated, the area of 'Exploration and exploitation of the Earth[44],' and 'Control and Care of the Environment[45]'. In 2007, the EU-27 countries together invested about 1.193 million EUR in R&D in the area of 'Exploration and exploitation of the Earth' (+38% compared to Y2000) and 1.920 million EUR in the area of 'Control and care of the environment' (+2.84% compared to Y2000).

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41 http://www.eurekanetwork.org/programmes/clusters

42 European Commission – JRC (2009), "Developing an analytical framework for mapping, monitoring and assessing transnational R&D collaboration in Europe - The case of the ERA-NETs", EUR 23843

43 GBOARD provides public funding figures and no expenditures and may include international cooperative initiatives like the European Space Agency (ESA).

44 Include the following R&D areas: General Research on the exploration and exploitation of the earth, Mineral, oil and natural gas prospecting, Exploration and exploitation of the sea-bed, Earth's crust and mantle excluding sea-bed, Hydrology, Sea and oceans, Atmosphere, Other research on the exploration and exploitation of the earth.

45 Include the following R&D areas: General research on the environment, Protection of atmosphere and climate, Protection of ambient air, Solid waste, Protection of ambient water, Protection of soil and groundwater, Abatement of noise and vibration, Protection of species and habitats, Protection against natural hazards, Protection against radioactive radiation, and Other research on the environment.

On average per inhabitant there is positive evolution over time for EU-27. Europe performs better per inhabitant than the US since 2007 (whereas it was lagging behind in previous years). On average over the period 2000-2007, public funding in 'Control and care of the environment' accounted for 1.5% of all EU-27 public funds for R&D (GBAORD). For the area of 'Exploration and exploitation of the Earth' the share amounted 2.6%.

EU R&D funding instruments and initiatives play a major role as a catalyst for the realisation of the ERA. A major role herein is played by the FPs. EC Directorate I 'Environment' has funded about 851 million euro under FP6, the majority going to R&D projects related to 'Pressures on environment and climate', 'Sustainable management of natural resources', and 'Environmental technologies'. Collaborative and integrated projects, involving participants from different countries and from industry and academia with a focus on developing new knowledge and technology to improve European competitiveness, were the most common (over 50%). FP6 projects that contain a major environmental component[46] but managed by other Directorates stand for over 386 million euro. Different 'Networks of Excellence' were setup in the areas of 'Earth observation', 'Marine environment' and 'Sustainable management of natural resources'.

Under FP7, up to January 2010, an amount of 578 million euro was granted, the majority going to projects related to 'Pressures on environment and climate', 'Environmental technologies', and 'Sustainable management of natural resources'. Here as well, collaborative and integrated projects were the most used instruments. Germany, UK, France and The Netherlands are the most active participants from the EU-27, whereas Norway and Switzerland head the ranking of the Associated States. Among the Third countries (which is indeed a quite heterogeneous group), the Russian Federation, China, India and Senegal are strongly represented.

National funds for environmental R&D are thus large indeed, but FP funding for environmental sciences is significant as well. The FP7 environmental R&D funding 'envelope' of 1.9 billion euro approximates the total public budget appropriations of the EU-27 countries for R&D in the area of 'Exploration and exploitation of the Earth'.

4.2.8 What national policies guide participation in national and EU funded sectoral and cross-sectoral environmental research projects? How do environmental research programmes and funding schemes in Europe select and assess research?

Each country has developed its own evaluation procedures and processes although increasingly (e.g. through so-called Open Methods of Coordination) there is an exchange and take-up of good practices. Important criteria are scientific excellence of the proposal and the scientific qualifications of the proposed team. Depending on the type of research funded (targeted versus non-targeted) different criteria are used and valued. In the context of the ERA-NETs it is important to make clear agreements about the administrative and evaluation procedures in the context of Joint Calls. In a broader sense, in the context of opening up national research systems as defined above, it is important that legislation on R&D funding and mainly eligibility criteria are further harmonised (see the previous discussion on funding to 'non-residents'). ERA-NETs have strongly contributed to the harmonisation of research evaluation processes and methods, also in other research areas besides environmental research.

[46] These projects have been identified through a keyword based search strategy that was applied on the titles and abstract texts of FP projects.

4.2.9 Strengths, weaknesses, opportunities and threats

To conclude, below we present a summarizing overview of the strengths and weaknesses of the ERA progress made in relation to this dimension, and the opportunities and threats related to future progress.

Strengths	**Weaknesses**
• Absolute and relative levels of public funding for environmental R&D have increased over time (EU-27 average); EU FP funding levels are very substantial compare to national R&D investment levels. • Half of the national R&D support measures are, 'on paper' at least, 'open' to foreign researchers (as a member of national research teams). • EU (and mainly FP) ERA promotion instruments and measures in the area of environmental research prove to be successful. o Collaborative and integrated projects are used at large. o Environmental ERA-NETs succeed in facilitating cross-border collaboration and have a positive influence on common programming and prioritization. o Environmental ETPs contribute to higher levels of industry relevant research and common prioritisation through multi-stakeholder involvement on various geo-levels. o KICs (2 out of 3 are relevant for environmental research) bring together academic, regional and corporate partners. o COST programme is also successful on cross-country prioritization and coordination of environmental research priorities. • Environmental research priorities do seem to converge between national and EU levels (and even international levels).	• Geo-political resistance towards cross-border funding flows (in the context participation of non-national researchers). • Regulatory barriers towards cross-border funding flows and harmonisation of programming and funding cycles. • Lack of systematic cross-border foresight and prioritisation initiatives (some compensation can be found as a result of the success of ERA-NETs, however). • Differences in evaluation methods and culture make the common appreciation of international proposals difficult, if not impossible (like in the context of ERA NET Joint Calls).
Opportunities	**Threats**
• To 'use' the budgetary constraints (as a result of the economic context) to emphasize the need for collaboration and to show the potential advantages of ERA. • In the 'thinking' of smart specialisation, to further think of what types of environmental research could/should be funded at EU level versus the national levels. • To develop a European/international evaluation protocol for the common evaluation of international proposals/project applications.	• National legislation and associated barriers that may prevent far reaching coordination of research programmes and priorities. • Economic crisis and budget cuts that may result in national prioritisation and focus.

4.3 Dimension 2: An adequate flow of competent researchers

4.3.1 What is it about?

This ERA-dimension deals with the availability and free movement (flow) of competent researchers, which relates to the following more detailed objectives:

1. Easy movement of researchers between disciplines and public/private sector.
2. Full opening of academic positions.
3. Absence of obstacles to transnational mobility.
4. Attractive conditions for men and women.
5. Single labour market.

Objectives 1, 2, 3 and 5 relate to large extent to the mobility of students and mainly researchers. These objectives refer to the free and easy movement of research between disciplines, between the private and the public sector in varying countries. They also refer to a more transparent and open recruitment policy at universities and research institutions. Objective 4 relates to the attractiveness of the research career position both for men and women, and touches also on the important issue of gender balance.

4.3.2 What is the current/future size and demographic (age, gender) profile of the environmental science post-graduate student population?

Although no precise data is available to exactly answer this question, we can nevertheless reflect on several aspects. A first important indicator providing information on future availability of researchers is the number of graduates. The average annual growth in the number of tertiary education graduates[47] in environmental protection for EU-27 is 15%. Estonia, Czech Republic and Latvia show large growth rates among the new Member States, while among the 'old' EU-15 countries Italy, France and Ireland perform well. The largest decrease in graduates in the education field of environmental protection is seen in Denmark (-22%) and in Belgium (-5%). Compared to other science fields (annual growth of 0.6%), the number of graduates in environmental protection is developing well (annual growth rate of 0.22%). The majority of graduates are moreover female, but the evolution in the number of male/female students since 2006 has become rather similar.

The number of researchers (entire population) in the field of natural sciences seems to be increasing in most of the countries for which there is data available (only 13 countries). When we look at the number of researchers employed in science and technology (HRST) in the broad economic sector of electricity, gas, water supply and construction (the only relevant category provided by Eurostat), we see that this sector stands for over 20% of total researcher employment (average in 2007 for all EU-27). In Portugal and Greece the shares are the lowest, whereas Germany and Belgium account for the highest shares.

[47] Graduates in ISCED 5 and 6 (ISCED97), field of 'environmental protection', 2000-2007.

4.3.3 What does existing literature say about the adequacy of the environmental researcher's demography from an ERA perspective?

'Adequacy' is interpreted here as a matter of availability and qualification. The situation in this respect differs from country to country. New Member States in particular are dealing with serious levels of 'brain drain' (or outward mobility), as a result of the less attractive local researcher career conditions. The main European countries seem to be struggling to find good researchers in environmental research and thus need to compete among each other. We also believe that this development, this competition, will increase in the coming years in view of the global competition for talented researchers.

The previously cited study on mobility of European researchers (MORE study) studied research mobility between the US and Europe. The respondents (not exclusively research in environmental research) were asked to indicate the country that was most attractive in their view for potential future mobility. Looking at all respondents' opinions the US seems to be the country that is most attractive for researchers (including researchers that actually have been in the US). EU-15 countries are a second best preferred destination. Factors that played a role in this choice related mainly to availability of research funding and quality of research.

ERA is one of the corner stones of EU 2020 strategy and future economic competitiveness of Europe. When it comes to skills and qualifications, there are certain concerns with respect to the Eco-industries sectors[48]. According to Skillsnet[49] the eco-industry will require employees with new skills and with a higher skill-level. Subsequently, they argue that there will be a shortage of skilled employees[50]. Numerous existing skills will become obsolete and therefore educating the current labour force is required to maintain competitive. At the same time this also needs to be taken into account when designing new curricula in environmental education (see also below).

4.3.4 What is the current/future size and demographic (age, gender) profile of the environmental researcher population?

At the Member State level, increasing attention has been devoted lately to the attractiveness of studies and curricula in natural sciences and engineering and the attractiveness of researcher careers. The number of researchers (the population) in the field of natural sciences seems to be increasing in most of the countries for which there is data available. In Portugal and Greece the shares are the lowest, whereas Germany and Belgium account for the highest shares. Nevertheless, there are concerns mainly on the availability of future skills (see previous question).

Doctoral students are also considered as researchers. Based on the CDH project[51] we can conclude that for both men and women together, natural sciences are the first or second major field of specialisation of doctorate holders (Estonia, Belgium and Denmark perform

[48] European Commission (2009), "Study on the Competitiveness of the EU eco-industry Within the Framework Contract of Sectoral Competitiveness Studies – ENTR/06/054, study lead by IDEA Consult in collaboration with Ecorys Netherlands, Flemish Institute for Technology Research and Ecorys Brussels Office.

[49] The early identification of skill needs network of Cedefop. http://www.cedefop.europa.eu/EN/about-cedefop/projects/identifying-skill-needs-in-sectors-and-enterprises/identifying-skill-needs-in-sectors-and-enterprises.aspx

[50] Strietska-Ilina (2008), Skills net, Enterprise surveys as a tool for skill needs analysis, http://agora.cedefop.europa.eu/skillsnet2008innet/UsersFiles/sa/documents/Presentetion2/12_Strietska.ppt#273,3

[51] OECD (2010), "CAREERS OF DOCTORATE HOLDERS: EMPLOYMENT AND MOBILITY PATTERNS", STI WORKING PAPER 2010/4, Statistical Analysis of Science, Technology and Industry

particularly well in this respect). Doctoral student in natural sciences represent at least 20% of doctoral graduates in all countries for which data are available, and more than 35% in Denmark, Belgium and Estonia.

4.3.5 What training provisions and standards for skilled persons are in place in the field of environmental research?

In terms of training provisions and standards many different instruments are used varying from country to country. What is more important, however, is to direct training provision and standards towards future needs. This can be done through skill forecasting analysis carried out by e.g. EU top research performers in collaboration with industry (e.g. environmental ETP platforms). When it comes to the Green Economy and the related economic sectors (and environment as a R&D field), the main conclusion is that there is not so much a need for new competences, as there is a need to adapt and upscale existing competences and skills[52] (cfr. supra). Significant investments in skill delivery are expected in economic sectors like energy efficiency and construction of zero-carbon homes, both of which are heavily driven by national legislation. Relative to topping-up existing skills sets and the more generic skills required, the more specialised, newer skills sets appear to be of less importance in moving towards a low-carbon economy[53]. Skills development responses ought to be prioritised in favour of building on existing skills sets, as well as improving the generic skills of people across the entire workforce. These generic skills refer both to skills required in almost any occupation – such as leadership, commercial understanding or management – and to generic green skills that should apply to any occupation. These largely relate to understanding how to prepare the workplace for new environmental legislation, and improving energy and resource efficiency.

The overall positive global competitive position for the EU eco-industry can only be retained if sufficient skilled labour can be attracted[54]. Especially in environmental engineering and technology, skill shortages have been reported. Potential actions include the introduction of specific environmental technology degrees in regular education, job training programmes by the companies itself, and lifelong learning initiatives, and a more flexible policy towards attracting high skilled non-EU talent. Additionally, actions for improving the transparency of the EU job market would certainly help in filling particular and temporal skills shortages in the EU.

4.3.6 What policies are in place to create jobs for environmental researchers?

Although systematic evidence on unemployment of doctoral holders (researchers) in natural sciences is scarce, the earlier mentioned CDH project did look into this. The CDH pilot data collection had revealed relatively higher unemployment rates of doctoral graduates in the natural sciences and engineering, which were probably a consequence of the economic downturn following the burst of the IT bubble (Auriol, 2007). This is less apparent in 2006, but there is still, according to the CDH report, a relatively higher unemployment rate of German doctoral graduates in the natural sciences (3.8% against 2.5% for all graduates). Policies to create jobs are in general related to broader sectoral development and industrial policies, where each of Member States sets its own priorities.

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[52] CEDEFOP (2010), "Skills for green jobs European synthesis report", http://www.cedefop.europa.eu/EN/Files/3057_en.pdf

[53] Ibid. [52]

[54] Ibid. [48]

In relation to general employment in the eco-industries sectors, a 2006 study[55] estimated total employment in the eco-industry is as follows (net FTEs):

- 1,845,000 direct jobs in pollution management (Solid Waste Management & Recycling, Waste Water Treatment, Air Pollution Control, General Public Administration, Private Environmental Management, Remediation & Clean Up of Soil & Groundwater, Noise & Vibration Control, Environmental Research & Development, Environmental Monitoring & Instrumentation.
- 500,000 indirect jobs in pollution management.
- 1,040,000 direct and indirect jobs in resource management (Water Supply, Recycled Materials, Renewable Energy Production, Nature Protection, Eco-construction).

This study states thus that the total direct and indirect employment due to Eco-industries represents approximately 3.4 million full-time job equivalents of which 2.3 million jobs come from pollution management activities. At a subfield level, largest growth rates between 2000 and 2008 have been in the Renewable energy sector (+16.37%), followed by the sectors of Recycled materials (+10.6%) and Noise & Vibration sector (+7.71%)[56]. Less growth was noted in the sectors of Wastewater management (+2.25%), Biodiversity (+2.73%) and Soil and Groundwater (+2.70%). A decline was note in the area of Air pollution (-2.10%).

4.3.7 What procedures are in place to recruit new staff? What percentage of posts in universities/public research establishments is held by non-nationals (breakdown by type of institutions, nationalities)?

A recent study carried out by the European University Association (EUA)[57] points out to several important issues. A first relates to the large differences in recruitment and evaluation procedures among universities, as a result of different public and private labour legal frameworks. The ability of universities to decide on staff recruitment is integrally related to its financial and academic autonomy as the 'contracts' with the funding bodies (usually the government) determine the freedom to operate. Staffing autonomy is thus quite limited, leading to large differences among countries. What is important to notice is the increasing openness in the announcement of faculty vacancies (e.g. through the EURAXESS portal). Concerning the number of non-nationals as staff of universities and research organisations, no statistics are available to our knowledge (several studies are currently looking into this). It is therefore important, and the EC is working on this under the implementation of European Researchers Partnership, to develop the conceptual framework needed and to perform a baseline measurement, and this not only in the field of environmental sciences.

4.3.8 What is the extent/pattern of transnational researcher mobility in environmental research?

Several countries are putting particular emphasis on the stimulation of mobility among students and researchers. To this end different support and funding measures have been introduced at various levels. A screening of national policies on career development and

[55] DG Environment 2006 "Eco-industry, its size, employment, perspectives and barriers to growth in an enlarged EU".

[56] Source: Eurostat, and Ecorys calculations

[57] European Association of Universities (2009), "UNIVERSITY AUTONOMY IN EUROPE I" Exploratory study by Thomas Estermann & Terhi Nokkala.

working conditions (based on Erawatch and country specific information) shows that the large majority of countries have specific measures in place to stimulate mobility (inward or outward mobility). Interesting is the large number of measures in new Member States, which seems to be a reaction to 'brain drain' type of phenomena. Many of the mobility support measures are often integrated in larger R&D support programs. Based on the Erawatch data we can say that about 60% of the measures related to researcher mobility are open to non-residents. Only a fraction of the overall measures, however, is dedicated to environmental sciences (about 15 measures in total).

What result to all these measures have? First of all we can observe an upward trend in the number of non-citizen students in the field of environmental protection (Eurostat data). As for a share of the total population of non-citizen students, we see that Switzerland and Belgium have the highest shares of mobile students in the area of environmental protection (whereas Slovenia, Hungary and Spain have one of the lowest). Typically, language barriers play a role here as in many countries there are legal restrictions towards the use of English for teaching.

At the student level, we can thus observe an upward trend in the degree of mobility in environmental protection (shares of non-nationals). Based on the previously cited MORE study[58], we see that the broader field of Natural Sciences and Technology, researchers are the most mobile compared to researchers in Medical Sciences and Agriculture or Social Sciences and Humanities. About 57%[59] of the researchers have been mobile, at least once during their career. The same study has pointed out that mobility leads to more networking, knowledge sharing and higher quality scientific work. Doctoral researchers working in Natural Sciences and Technology fields are more likely to have been internationally mobile in the last three years (34%) than researchers at any career stage in any other broad scientific domain. Precise information on the mobility intensity of environmental researchers is not available but could be part of a future study in this area.

4.3.9 What are the barriers to transnational researcher mobility in environmental research?

We have no indications that the barriers related to mobility of environmental researchers are any different from the barriers faced by researchers in other scientific disciplines. Recent research (MORE study)[60] showed that there are differences between academic and industrial researchers. For Higher Education researchers, personal/family factors are an explanatory factor for lack of mobility whilst quality of life motives, career progression goals, personal research agenda goals and training and development goals are all explanatory factors for mobility. Research-related factors such as access to appropriate research facilities and collaborators, or levels of and ability to access research funding are more important factors in determining the attractiveness of a potential 'target' country for international mobility than are salary and incentives. Labour market and immigration policy factors seldom seem to be important either as 'push' factors encouraging researchers to leave a particular national system or as 'pull' factors attracting researchers to a particular system. However, they do register as difficulties encountered by researchers in their own experiences of mobility. Finally, child care arrangements are important mainly to female researchers than to males (among the

58 Ibid. [60] (survey on Higher Education).

59 This is a representative number for the entire EU-27.

60 European Commission (2010), "Mobility and career paths of European Researchers – policy relevant findings and recommendations", study development by IDEA Consult et al., reports are available at: http://ec.europa.eu/euraxess/index.cfm/general/researchPolicies

mobile researchers). This factor is also very important for non-mobile researchers and prevents them from becoming mobile.

In general, academic researchers did not seem to consider the practical influencing factors (immigration regulations, pension systems, language, etc.) to be that important. Although there are clear nuances between different groups of researchers, in general access to facilities and high level knowledge, seem to be clearly influencing factors in the decision to become mobile. As a result, further opening up of research facilities is an important factor for the stimulation of mobility among researchers.

4.3.10 What incentives exist at EU/national level to overcome the barriers to transnational researcher mobility in environmental research?

The European Partnership for Researchers[61] (EPR) is one of the most important European initiatives that targets the improvement of researcher careers and stimulation of mobility. When it comes to mobility of researchers, both on the regional and national levels, significant efforts have been undertaken and clear results have been achieved. However, challenges remain, mainly in the area of social security transferability and open recruitment policies. Concerning the latter it seems that mainly larger institutions are making progress, opposed to smaller ones that are still preoccupied with developing their scientific profile and performance.

The European Commission has put in place a number of important instruments to stimulate research mobility and better researcher careers, the well-known 'umbrella' of Marie Curie Actions is one of them, and EURAXESS is another example. At the student/graduate levels there are also the well-known and very important support programmes Tempus and Erasmus Mundus.

In environmental sciences there have been 106 Marie Curie Actions - MCA (or 57 million euro) funded under FP6 and 56 under FP7 (or 23 million EURO). The average amount per funded action has decreased under FP7 (from over 500.000 euro to around 400.000 euro). Most of the FP6 funded MCA actions took place in the subarea of 'Environmental monitoring' (36%), followed by 'Environmental modelling' (22%). The lowest number of MCA actions was registered in the areas of 'Waste management' (1%), 'Recycling' (1%) and 'Noise reduction' (3%). In the transition towards FP7, we see that the number of MCA actions in these subfields has increased somehow. The UK is a very 'active' destination, followed by Germany, France and Spain. Higher Education Institutes are the most active, although in the area of 'Air cleaning technologies' there is also a strong industry involvement, just as in 'Environmental monitoring' and 'Environmental modelling'. A positive evolution for environmental sciences can thus be noted in the transition from FP6 to FP7.

To conclude, the Framework Programmes and the Marie Curie Actions, the adoption and implementation of the European Charter for Researchers, and the Code of Conduct for the Recruitment of Researchers, the 'scientific visa' package, and the integrated European Researcher Partnership are all important policy initiatives; the impact of these policies on the development of the environmental ERA will become more visible in the (near) future.

[61] European Commission, "Better careers and more mobility: a European partnership for researchers" [COM(2008) 317 final].

4.3.11 Strengths, weaknesses, opportunities and threats

In order to summarize the above presented discussion, we present below an overview of strengths and weaknesses of progress made so far, and opportunities and threats related to the way forward. Important to note is that many of the indications presented above do not particularly concern the position of researchers in environmental sciences, bur rather, researchers in general.

Strengths	**Weaknesses**
• The number of tertiary education graduates in the field of environmental protection is evolving positively in most of the countries (despite the decrease in Denmark and Belgium); there is moreover a 'gender balance'. • The number of researchers active in the field of natural sciences is increasing over time as well. • High (and increasing) levels of mobile students (field of environmental protection) and researchers (natural sciences). • Member States are putting significant efforts in inward and outward mobility support schemes (across disciplines). • EU mobility support schemes play an important role in the stimulation of research mobility (e.g. EURAXESS, Marie-Curie, collaborative/integrated FP projects). • Between 2000 and 2008, then number of employees in the so-called Eco-industries has increased strongly (e.g. in sectors of renewable energy and recycled materials).	• There are still discrepancies in staff recruitment and reward policies between countries and institutions. • Relatively high unemployment rates of doctorate holders in natural sciences, which may suggest a mismatch between industry demands and the profile and skills of the doctorate holders. • Skill shortages in environmental engineering and technology. • Obstacles to transnational mobility still remain (not particularly for the area of environmental sciences). • Between 2000 and 2008, general employment in the Air pollution sector shrunk with 2.10%.
Opportunities	**Threats**
• Further empower national research institutions and universities (in certain countries) in order to be more flexible in dealing with researcher needs. • Carry out directed skill forecasting exercises in order to map future needs, and to better align training provisions and standards to future needs (in collaboration between industry and academia).	• The US seems to be more attractive as a destination for researchers than the EU (all science fields). This might be a disadvantage in the battle for 'brains'. • Future (increasing) shortage of qualified researchers and workers in the so-called Eco-industries which may result in EU loosing its competitive position. • New Member States mainly face brain drain so that they cannot fulfil their local research needs (this may jeopardize the solidarity towards EU policy).

4.4 Dimension 3: Excellent research institutions

4.4.1 What is it about?

The ERA dimension on the development of excellent research institutions encompasses the following objectives:

1. Realisation of excellence in performance.
2. Realisation of virtual research communities.
3. Towards clusters of research and innovation.
4. Easy collaboration with industry.
5. A model of competition and collaboration.

On the one hand there is the ambition to create excellent performing institutions, both on the scientific level but also in terms of innovation. On the other hand, these institutions should collaborate and also compete in Europe and the World. This should/could lead to virtual research communities and clusters, like the ones facilitated through the ERA-NETs, the Networks of Excellence, and the Knowledge and Innovation Communities (KICs) under EIT.

4.4.2 What does existing literature say about the adequacy of environmental research institutions to foster ERA?

Europe and it associated countries, have a number of top-performing research institutions in environmental research. These organisations are key members of associations such like EIROForum (which groups CERN, EFDA-JET, EMBL, ESA, ESO, ESRF, ILL and XFEL) or EARTO, EuroHORCs, ESF, or TAFTIE, ALLEA and EASAC. There is no specific literature to our knowledge that deals with this particular question, but from the analysis of the collaboration between the European top-institutions (in FP-projects but also on the basis of their co-publications) it seems that competition often prevails over cooperation. For example, we hardly find examples of collaboration between the top-institutions and based on our collaboration network analysis, we see that the majority of the top-institutions have developed their own network of partners.

There certainly is a huge variety among countries and cultures, where factors like institutional autonomy, levels of basic funding, traditions of collaboration with industry play a role as well when it comes to collaboration choices. It is clear that further reforms are needed[62] (in relation to autonomy, funding of excellence, collaboration, stimulation of 'entrepreneurship' etc.) in order to strengthen ERA in respect of excellence, competition-collaboration balance, and easy collaboration with industry.

In the ex-post impact assessment of the FP6 sub-priority 'Global change and ecosystems', reference is made to the need of exchanging and diffusing knowledge between different research communities. There is a risk that new fields/research findings are not captured and internalised by the existing research organisations as a result of "the perimeters of

[62] European Commission (2008), "Strengthening research institutions with a focus on university-based research", report of the ERA expert group.

established institutions, including funding agencies that do not match the frontier of these emerging domains". Often this comes down to being open for new combinations of existing knowledge. Public action, in the sense of providing new funding opportunities for combinations of new knowledge (e.g. towards FP8), might be sensible here. Moreover, strategic collaboration between leading EU and associated country institutions is essential.

4.4.3 Which are the leading European environmental research institutions and what is their level of global competitiveness?

'Leading' can be considered from different perspectives. A first perspective is the role and participation in FP6 and/or FP7.

- Under FP6 (in core environmental research projects) the following institutions often appear most often as coordinators of consortia (based on volume of participation in euro's): Natural Environment Research Council (UK), the Consiglio Nazionale delle Ricerche (Italy), the Helmholtz-Zentrum fuer Umweltforschung GmbH (Germany), the Centre National de la Recherche Scientifique (France), and the Max Planck Gesellschaft zur Foerderung der Wissenschaften E.V. (Germany).

- Under FP7, the most active coordinating institutions are (based on volume of participation in euro's): Natural Environment Research Council (United Kingdom), the Bureau de Recherches Geologiques et Minieres (France), the Nederlandse Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek (Netherlands), Alterra B.V. (Netherlands), and Max Planck Gesellschaft zur Foerderung der Wissenschaften E.V. (Germany).

A second perspective is to look at the leading environmental research institutions based on the number of scientific publications (all environmental subfields, period: 2000-2010). Leading institutions are[63]:

- Consejo Superior de Investigaciones Cientificas (Spain), Consiglio Nazionale delle Ricerche (Italy), University of Helsinki (Finland), the University of Wageningen (Netherlands), and the University of London Imperial College of Science, Technology & Medicine (United Kingdom).

- In terms of numbers of received citations, we find the Free University of Amsterdam (Netherlands) to be leading the ranking with 18.92 citations per paper (CPP), followed by the Stockholm University (Sweden – CPP: 17.09), the National Institute for Public Health and the Environment (Netherlands – CPP: 17.03), and the State University Ghent (Belgium, CPP: 17.03). Compared to the non-EU institutions, we find Environment Canada (Canada – CPP: 20.44), US Environmental Protection Agency (United States – CPP: 18.63), and the University of California, Berkeley (United States- CPP: 15.49) in the highest positions. The Swiss Federal Institute for Environmental Science & Technology is leading worldwide in terms of citations, followed by Environment Canada, and the Free University of Amsterdam that performs better than the US Environmental Protection Agency. To conclude, Europe has a number of leading environmental research institutions that are competitive at the global level as well.

[63] Source: Thomson Reuters

A third perspective is to look at the number of patent families with respect to environmental technologies (all subfields, period: 2000-2010) [64]:

- Fraunhofer Gesellschaft zur Foerderung der Angewandten Forschung E.V. (Germany), the Centre National de la Recherche Scientifique (France), Consejo Superior de Investigaciones Cientificas (Spain), Centro Ricerche Fiat SPcA (Italy), Delft University of Technology (Netherlands), and Commissariat a l'Energie Atomique (France). Leading non-EU organisations are the University of California (USA), University of Tohoku (Japan), University of Tokyo (Japan), University of Nagoya (Japan), and the University of Hiroshima (Japan).

In terms of global scientific and technological strength, we see that among the top-100 worldwide leading environmental research institutions, 25 are EU and associated country institutions. The Spanish Consejo Superior de Investigaciones Cientificas and the Consiglio Nazionale delle Ricerche (Italy) are respectively on the 4th and 8th positions, followed by the University of Helsinki (Finland) on the 18th position.

4.4.4 What are the characteristics (multi-dimensional) of leading European environmental research institutions?

A full analysis of the characteristics of the top-performing institutions would require a case-by-case analysis.

However, what are the main characteristics? Many of the top-performers are public research institutions (often state owned), with a long history (they are around for quite some time) and tradition, that enjoy (or have enjoyed) significant amounts of public funding. Many of them are multidisciplinary in nature and thus are able to combine expertise and knowledge. Critical mass and availability of major research infrastructure facilities are other important characteristics. Quite often these institutions also have 'national' tasks and obligations (national and international representation functions) and thus have strong networks, both national and international. Finally, these institutions have well-developed administrative support units, essential for managing large scale research projects.

Top-performing institutions perform well over a broad spectrum of activities. Excellence creates the basis for more excellence. What is challenging in this respect are the possibilities offered to new-comers (e.g. organisations from new Member States) to develop the required excellence in order to play a role of importance. It is here where the concept of 'smart specialisation' should/could come in. For example, it would be more sensible, from an ERA perspective, for new Member States to develop complementary expertise and excellence, rather than trying to compete in areas where existing institutions have already developed strong capabilities. This would require collaboration in the development of a joint vision (e.g. through foresight exercises) and certainly political leadership.

In order for research organisations to develop a critical mass and to become excellent, it is important that they have access to substantial research funds (both at EU and the national level). This certainly depends on the specificities of the science field in question. E.g. research in biotechnology, but also in environmental science fields, is costly and requires development and access to top-class research facilities. On the role of the Framework Programmes for the creation of research excellence, it is clear that the FP

[64] Source: Thomson Reuters

support programmes mainly stimulates the achievement of higher levels of already 'existing' excellence, rather then the creation of 'new' excellence.

4.4.5 To what extent do leading European environmental research institutions interact with each other?

The key players, the large (and leading) research institutions in environmental research seem to have developed their own networks of partners, and do usually seek for 'complementary' expertise. Based on the network visualisation analysis of collaboration patterns (in FP), we see strong sub-networks around the key institutions. The network positions of the best performing research institutions (on the basis of FP6 and FP7 participation volume), reveal centrality, i.e. these institutions take a central position in their networks and are as such 'hubs' of collaboration towards other organisations.

This is also confirmed by the co-publication analysis, which hardly reveals any collaboration between for example top-players like the Consejo Superior de Investigaciones Cientificas (Spain) and the Consiglio Nazionale delle Ricerche (Italy) or between the Centre National de la Recherche Scientifique (France) and Consejo Superior de Investigaciones Cientificas (Spain) – as an illustration. Collaboration among leading institutions is not structural as a result of competition for funding and prestige. The balance between collaboration and competition could be improved in this respect for the benefit of ERA and society at large (i.e. collaboration on a 'strategic' and not only at the 'operational' level; see also the discussion under Dimension 1).

Finally, despite the organisation specific motives to collaborate or not, there are also 'external' barriers towards collaboration[65]. Major factors are: the increasing competition for funding (both on national and the international market), narrow national funding base, the availability of EU-wide research infrastructures, and the internationalisation of industry which strengthens a competitive model. Industry demands excellence and works only with excellent institutions (regardless of their geographical location), leading to national and international competition for funds.

4.4.6 To what extent are leading European environmental research institutions hampered by administrative red tape in national and EU organisations?

It is clear that administrative red tape plays an important role despite significant improvements resulting from administrative simplification efforts/projects at national and European levels. The situation differs from country to country. Large research institutions are also hampered, but the impact of red tape is more severe on smaller research organisations, for example organisations from new Members States that do not have the knowledge or the means to deal with heavy administrative obligations. Our experts do agree that a lot of improvement has been booked, although more is still needed. In particular in relation to the ERA-NETs, several interviewees indicated the need to critically consider the administrative requirements.

4.4.7 To what extent are leading European environmental research institutions supported administratively for research project management?

Leading European environmental research institutions (in particular in relation to FP participation) frequently benefit from long term experience and professionally developed administrative support units that deal with administrative project formalities. As a result, researchers can focus primarily on research without having to worry too much about administrative obligations. There is also often the possibility to obtain support from so-called National Contact Points, in several countries. These Contact Points can provide advice on how to deal with administrative requirements.

[65] European Commission (2008), "Coordination and Cooperation - Research Performing Organisations (RPOs)"

4.4.8 Strengths, weaknesses, opportunities and threats

In order to summarize the above presented discussion, we present below an overview of strengths and weaknesses of progress made so far, and opportunities and threats related to the way forward.

Strengths	**Weaknesses**
• Europe has several leading environmental research institutions able to compete at global level (in scientific and technological terms). • EU support channels/instruments (e.g. ERA-NETs, KICs, Networks of Excellence, and FP-instruments like collaborative and integrated projects) provide opportunities for collaboration. • Leading institutions combine disciplines and expertise, and are leading on many 'parameters'.	• The balance between competition and collaboration among leading European research institutions is tipping towards competition. • Lack of 'strategic' collaboration among the leading European environmental research institutions at the expense of society at large. • Significant burdens related to administrative red tape (or at least the perception thereof).
Opportunities	**Threats**
• Investigate 'strategic' collaboration possibilities among leading European and associated countries' environmental research institutions (e.g. through the analysis of common challenges). • Further reduce barriers towards cross border collaboration. • Institutions from new Members States could develop complementary expertise and excellence, rather than trying to compete in areas where existing institutions have already developed strong capabilities ('smart specialisation'). Strategic partnerships could be concluded to this end. • 'Showcase' EU's and associated countries' leading environmental research institutions internationally in order to attract foreign researchers.	• Not being able to recognize and/or stimulate the emergence of new research fields due to fixation on existing capabilities. • Economic crisis and the decline of national budgets for environmental R&D (which will lead to more competition at the international level).

4.5 Dimension 4: World-class research infrastructures

4.5.1 What is it about?

The ERA dimension on the development of world-class research infrastructures encompasses the following objectives:

1. Infrastructures should be integrated, networked (also through ICT).
2. Accessibility of EU researchers to infrastructure and equipment in other parts of the World.
3. Accessibility across Europe and the world.
4. Joint European Ventures.

Research infrastructure (RI) is a quite broad term, referring to: "*facilities, resources and related services that are used by the scientific community to conduct top-level research in their respective fields*." [66]

This definition covers major scientific equipment or set of instruments; knowledge based-resources such as collections, archives or structured scientific information; enabling ICT-based infrastructures such as Grid, computing, software and communications; any other entity of a unique nature essential to achieve excellence in research. Such research infrastructures may be "single-sited" or "distributed" (a network of resources).

4.5.2 What does existing literature say about the adequacy of environmental research infrastructures to foster ERA?

In their ideal state the adequate environmental research infrastructures should be integrated, networked and accessed through the concomitant development of new generations of electronic communication infrastructures, both in Europe and globally[67]. An important advantage of these infrastructures comes from the fact that they help to remove the traditional constraints for information exchange caused by geographic distance, research discipline, and institutional differences.

In addition, RI should have adequate facilities[68] such as:

- Equipment (connected to programmes).
- E-infrastructure.
- High capacity and high-performance communication networks (GÉANT).
- Grid-empowered resource sharing infrastructures.
- Super-computing facilities combined with scientific application software, data repositories and advanced visualisation.

[66] European Commission (2008), "Developing World-class Research Infrastructures for the European Research Area", report of the ERA Expert Group

[67] European Commission (2007), Green Paper on the European Research Area

[68] European Commission (2010), A vision for strengthening world class research infrastructure in the ERA . Report of the Expert Groups on Research Infrastructures.

In general, Europe has achieved good progress in the development of a more coordinated approach for policy-making in the field of RIs in all areas of research[69]. We obtain a similar appreciation among the experts in environmental policy and research (about 58% of the experts state that the ERA has made some progress towards the development and sharing of world-class infrastructures, while 28% of experts describe this progress as being major.). The share of expenditures for environmentally oriented infrastructures in the total volume of planned RIs is considerable, which points at good growth potential for such RIs in the future (about. 2.2 billion EUR out of 13.8 billion EUR projected for all planned RIs).

The EU financing represents a small share of total financing of the RIs which is mainly driven by the Member states. Thus, among challenges to the development of adequate environmental RIs we can name greater need for coordination among Member States, especially with respect to their legal and administrative frameworks.

4.5.3 What are the main existing environmental research infrastructures at EU and national level?

When looking at the distribution of research infrastructures in Europe from the pure quantity standpoint, we observe that, in particular Germany (67 RIs) and France (47) have a large number of environmental RIs compared to the rest of Europe. Among the new Member States Poland stands out as having relatively more (9) environmental RIs in place than other new Member States. The existing environmental RIs are active in a wide variety of research fields. The five most dominant research categories are: oceanic and marine data centres, natural history collections, research aircrafts, atmospheric measurement RIs, and research vessels. It is also observed that among the old and the new Member States the larger countries have on average a larger number of environmental RIs.

New initiatives to support RIs financed under the FP6 and FP7 are addressing two fundamental issues[70] that held back research in this area:

- The inability to raise funds to create large RIs.
- The difficulty to coordinate the research between European RIs.

The majority of environmental RIs in Europe are rather small (compared to such domains as Material Science and Physics according to ERID Watch Deliverable 12). 49% of RIs employ only 1-10 employees, another 25% employ between 11 and 50 people. In general, most environmental RIs have had cumulative investment costs for initial construction/set-up of less than 20 M€ each.

For many of the environmental RIs, operational costs amount to less than € 10M a year; only about 14% of environmental RIs require operation costs in surplus of € 10M a year. All the environmental RIs financed by FP7 have their cumulative investment cost at levels below 10 million EUR.

4.5.4 What are the main planned environmental research infrastructures at EU and national level?

Europe has taken an important step forward in the development of a more coordinated approach for policy-making in the field of RIs with the establishment of the European

69 Ibid. [68]

70 Ibid. [68]

Strategic Forum on Research Infrastructures (ESFRI). The ESFRI roadmap includes 7 environmentally oriented research infrastructures. The estimated total construction cost for the planned ESFRI research infrastructures is 13.6 billion euro while the estimated total cumulative construction cost of 325 existing medium- and large-scale research infrastructures (excluding ESA) is 33.85 billion euro.

Part of the ESFRI roadmap is attributed to RIs in environmental sciences. This includes RIs "focusing on the knowledge needed for the promotion of sustainable management of the natural and human environment and its resources" [71]. Furthermore, "Current emphasis is on the prediction of climate, ecological, earth, atmosphere and ocean systems changes, on tools and technologies for monitoring, prevention and mitigation of environmental risks and pressures".

The ESFRI roadmap includes 11 planned research infrastructures in 4 different categories of environmental sciences (atmospheric sciences, biodiversity, climate change, and soil earth sciences). For the 7 of the listed environmentally oriented planned RIs the total construction cost is expected approximately at the level of 2.2 billion euro. Important to note is also the major 'up-scaling' of facilities and equipment that took place in the previous years, mainly in the new Member States and with the support of, among other, the Structural Development Funds (ERDF).

Under the 7th Framework Programme, the Commission has funded the preparatory phases for 34 projects included in the 2006 ESFRI roadmap. First indications show that the effects induced by the preparatory phase have a positive impact in order to move these projects forward towards construction. Since the publication of the ESFRI a number of additional new environmental RIs were planned by the Member States, such as new research vessels in Germany and research and observations stations for the Arctic and Antarctica commissioned by Norway.

One recurring issue with regard to funding is the difference between securing the funding for construction and the long term commitments needed for funding of operation and upgrades. It has been found that financing of the construction costs is frequently granted outside of the current research budgets (e.g. from structural and/or other local funding, according to ERID Watch). By contrast, the needed long term commitments for operation and upgrades have to be found in tight research budgets, and one can expect that such pressure grows with each newly added facility. Therefore more dedicated efforts towards support of research infrastructures and their coordination can be seen as a way to improve progress in this direction.

4.5.5 What is the contribution (public and private) by country to the creation of ESFRI roadmap environmental research infrastructures?

The Member States have at their disposal several mechanisms to contribute to the creation and development of ESFRI roadmap in all research fields. The ESFRI national delegates represent the views and strategy of their Member States concerning RIs. They play an important role in integrating and coordinating their national priorities within a common European framework. The representatives of Member States serving as Framework Programme Research Infrastructures Committee Members are involved in decision making regarding the preparation and setting out the EU-level work programmes.

Furthermore, the National Contact Points (NCPs) provide necessary assistance to the RIs in Member States in preparation of proposals for the EU support and help in

[71] European Commission (2008), ESFRI Roadmap Update.

disseminating the information about the EU activities. The comprehensive data about the exact ratio of EU and national funding is not available. Nor is it available for the environmental RIs in particular. When looking at the total numbers provided on the RIPortal regarding the Member States' annual funding for all RIs (which is estimated at around 90% of their total costs) we see that Germany, France and the UK provide the most financial support to these RIs with own shares of 30%, 24% and 17% of the total Member State funding of the RIs respectively.

While some individual countries have already invested heavily in developing research infrastructures, they tend to need partners to be able to provide all of the necessary state-of-the-art facilities. High initial and operational costs, along with local demand (particularly in smaller countries), place restrictions on national developments. Some Member States have their own RI policies, which include optimising existing facilities and developing new ones. Many EU countries have started to identify their national RI needs for the future: the resulting national roadmaps define not only national priorities, but also stress the importance of participating in international facilities.

4.5.6 How accessible are European environmental research infrastructures?

The environmental RIs are relatively well accessible to external and international researchers. The vast majority (more than 90%) of the existing research infrastructures are open to European participants with a relatively large percentages (54%) also being available for the use by researchers from Third Countries.

Nonetheless, the ERID-watch deliverable 12 states that among the interviewed infrastructures (in all research areas), no special programme for the staff exchange with industry exists. Assuming that the RI research management practices in different science fields are similar, it can be expected that such a situation is likely to occur in environmental research infrastructures as well. Therefore, greater coordination between the RIs' research agendas and existing researcher mobility schemes is seen as a way to establish greater mobility among the environmental RIs and with their partners/users as well.

4.5.7 To what extent do European environmental research infrastructures carry out research and train researchers?

The data about the training activities at the environmental research infrastructures is not available at the moment, but it is possible to make general observations based on the ERID Watch study[72]. Two thirds of the RIs interviewed in the ERID-Watch (in all research fields) have indicated providing full spectrum of research services to external users and some additional services, such as training. The report indicates that they are actively publish results of their research in scientific journals and on average have a number of students and research assistants involved in the infrastructure's operations. Other forms of dissemination such as patenting and licensing do not appear to be inherently related to the use of RIs according to the report.

The ERID-Watch deliverable 12 (final report) also reports on Human Resources, which appears to be a field where several research infrastructures perceive a number of problems. Fixed-term contracts with no clear future option or (tenure) track, low salaries in comparison to industry and difficulties to recruit appropriate staff, especially engineers and technicians, seem to be severe problems for the Research Infrastructures in different

[72] European Commission (2009), ERID-Watch: Deliverable 12 Report.

science fields. These are challenges that are faced by research institutions in general as well.

4.5.8 *What standards do European environmental research infrastructures maintain for data production and sharing?*

There has been considerable effort to ensure high degree of accessibility and compatibility in data production and sharing processes. The e-Infrastructure Reflection Group (e-IRG) contributed significantly through its recommendations both to the European Commission and the Member States by supporting of the creation of a political, technological and administrative framework for the easy and cost-effective shared use of distributed electronic resources across Europe[73].

In the area of data storage and exchange an important source for standards and common practice information is provided by the INSPIRE directive[74] which came into force on 15 May 2007 and aims to create a European Union (EU) spatial data infrastructure. Based on the experience of the Lifewatch biodiversity data project[75] it is possible to underline several important data production and sharing aspects[76] specific for environmental RIs, such as networking, high performance computing, remote access and remote instrumentation, data infrastructures and persistent storage.

In general, this aspect of the RIs activities appears to be well organized and coordinated. At the inception stage of such infrastructures the conditions for information accessibility and sharing, technology standards, etc. are inherently observed and integrated in the infrastructure development plans.

4.5.9 *To what extent are European environmental research infrastructures networked inside Europe?*

There are indications of active participation of the European environmental research infrastructures in intra-European networks. More than 85% of environmental RIs participated in EC-funded projects and 58% participated in non-EC funded European programmes/projects. These two numbers provide indirect evidence of relatively active participation in the inter-European Member State networks among the environmental RIs. Furthermore, there is evidence that the international (worldwide) accessibility of European environmental RIs for external users is rather good (see question 4.5.6). Here we talk about the so-called 'declared access' possibilities.

The actual numbers regarding the external usage and cooperation with other RIs and RPOs are not available. The interviewed experts, though, indicate that the degree of networking and cooperation in the environmental RIs is similar to that in other research institutions.

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73 eIRG Blue Paper, 2010.

74 European Commission (2007), Directive 2007/2/EC of the European Parliament and of the Council of 14 March 2007 establishing an Infrastructure for Spatial Information in the European Community (INSPIRE).

75 http://www.lifewatch.eu

76 According to the e-IRG Blue Paper the standards and common practices in this framework cover a number of aspects critical for effective electronic communication: Networking; Authentication, Authorisation and Accounting; Grid, Cloud and Virtualisation; High Performance Computing; Remote Access and Remote Instrumentation; Data infrastructures and persistent storage; Virtual Research Communities and collaboration.

4.5.10 *To what extent are European environmental research infrastructures networked outside Europe (US, Japan, BRIC countries)?*

According to the data from RIportal[77] the vast majority (77.85% of RIs) cooperates on a multi-lateral basis with other research infrastructures/organisations/institutions outside Europe. A similarly large number of environmental RIs (71.81%) have participated in international programmes/projects extending beyond Europe funded as well by the EU and the national governments. More than half the RIs (59.06%) cooperate at least on a bilateral basis with other research infrastructures/organisations/institutions outside of Europe.

On average, European environmental RIs have indicated that they are involved in 5 "main international structured cooperation research projects" (financed by at different levels); some are even involved in up to 29 such projects. One can expect that the degree of extra-EU international networking in environmental sciences should be higher than in other research fields. The environment is a global phenomenon, which can not be contained to the limits of one geographic entity even such a large one as the EU.

4.5.11 *What EU and national schemes exist to promote environmental research infrastructure based research collaboration?*

According to RIportal [78], some indication on the funding/support structure of environmental RIs is provided:

- 87.59% of environmental RIs use some kind of national public funding.
- 27.59% of environmental RIs use some kind of multinational/international public funding.
- 20.00% of environmental RIs use some kind of national private funding.
- 6.21% of environmental RIs use some kind of multinational/international public-private funding.

This allows us to infer that while most environmental RIs are still supported by national public funding, over one third of the environmental RIs do receive support from multinational/international public-private funding. This offers an information proxy for the intensity of national and international support to environmental research infrastructures. The systematic information about particular national support schemes directed at support for research infrastructures (apart from the data on FP funding) is not available. In general, such forms of support often comprise an element of the broader innovation, science, and environment policy measures.

The EU efforts are devoted to addressing the two fundamental issues that hold back the development of research infrastructures in the area of environmental research: the inability to raise funds to create large RIs and the difficulty to coordinate the research between European RIs, which links to the overarching challenge of coordination of research priorities in Europe.

At the European level under the FP6 the European funding has been provided mainly to the networks of infrastructures under the Integrating Activities [79] or Coordination

[77] http://www.riportal.eu

[78] Ibid. [77]

[79] Integrating activities combining cooperation networks with transnational access and research projects and the Integrating activities including networking activities only.

Actions[80]. This effort has intensified with the start of the FP7. Currently the overall objective of the 'Research infrastructures' part of the FP7 Capacities programme is to optimise the use and development of the best research infrastructures existing in Europe.

In August 2009, a Community legal framework for the setting-up of large research infrastructures in Europe has entered into force. The Community legal framework for a European Research Infrastructure Consortium (ERIC), adopted by the Council in June 2009, is an easy-to-use legal instrument providing[81]:

- The spirit of a truly European venture.
- Legal personality recognized in all EU Member States.
- Flexibility to adapt to the specific requirements of each infrastructure.
- Some privileges / exemptions allowed for intergovernmental organisations.
- A faster and more cost efficient process than creating an international organisation.

At the national level the support measures for environmental research infrastructures are mainly provided in the framework of general R&D support policies. These measures range from the dedicated large RI financing facilities (in the United Kingdom, Italy and Iceland) to the competence/expertise centre measures (in Finland, France, Norway, and Sweden). It is interesting to point out that in the quantitative terms the New Member states have more support measures related to research infrastructures than the old ones.

4.5.12 To what extent and how do ERA-NETs impact upon environmental research infrastructures?

Some of the environmental ERA-NETs (such as BONUS, BIODIVERSA and COASTAL in FP6, DC-NET and ERA-INSTRUMENTS in FP7) have clearly integrated the issue of infrastructure development in their agendas. Among such activities we can mention calls for research infrastructure integration projects, calls for joint use and planning of research infrastructures, creation and providing access to the inventory of available RIs inside and beyond the ERANET[82],[83].

The main objectives of these ERA-NETs related to the support for environmental infrastructures aim at achieving greater coordination and overcoming fragmentation in management and use of different environmental RIs. Among particular objectives it is worthwhile to mention an objective declared in the BONUS project related to integration of the candidate countries into new funding schemes.

4.5.13 To what extent and how do ETPs impact upon environmental research infrastructures?

While there is a positive interrelation between the ETPs and the activities related to environmental ERA, the direct effect of the ETPs on European research infrastructures in the field of environmental research is difficult to isolate. There is evidence of the RIs involvement in co-developing the strategy of the ETPs, and vice versa. The effects generated by the ETPs are much less visible due to the fact that the ETPs impact is realized indirectly via other policies and programmes with a considerable time delay. The

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80 Co-ordination actions intended to promote and support the co-ordinated initiatives of a range of research and innovation operators, in order to achieve improved integration of the European research.

81 European Commission (2009), COUNCIL REGULATION (EC) No 723/2009 of 25 June 2009 on the Community legal framework for a European Research Infrastructure Consortium (ERIC)*

82 http://www.biodiversity.be/biodiversa/

83 http://www.bonusportal.org/about_bonus/bonus_era-net/

ETPs are seen as supportive instruments for the ERA and compared to RIs they are more focussed towards turning research into innovations that can help remedy societal problems across Europe (and worldwide).Thus the ETPs are expected to show interest for research infrastructures specializing in more applied research. The ETPs have been involved in determining general priorities for the ESFRI roadmap for research infrastructures and for a number of initiatives in the framework of the Structural Funds and the European Investment Bank's Risk Sharing Finance Facility. [84] Nonetheless, the ETP Expert Group has advised that the ETPs act even more actively in determining the agendas and priorities in the European research infrastructures development programmes.[85]

The environmental ETPs related to environmental objectives (and therefore have a more direct relation to the field of environment) have initiated or have participated on average into 9 specific research programmes, projects, taskforces or conferences, while non-environmental ETPs only reach an average of 2. The environmental research infrastructures are involved in a number of the ETP via Strategic Research Agenda's. Germany is the country with the most active involvement in the environmental technology platforms (30 institutions), followed by France (20 institutions). Germany is also strongly engaged in the RHC platform (Renewable Heating and Cooling – 7 institutions) and the Forestry platform. France has a strong involvement in the Biofuels platform. Most countries are 'modestly' involved in the different ETPs.

Finally, the ETP expert group has recently issued the recommendation that at the European level, the ETPs should become involved and determining the themes and topics for cooperation and research infrastructure programmes, and also should become one of the main sources of input when, for example, screening proposed research topics, providing recommendations and suggesting priorities for different research support programmes.[86]

4.5.14 What other EU and national support mechanisms exist for environmental research infrastructures?

In addition, at the EU level we find the following programmes directly and indirectly contributing to the development of the research infrastructures and the environmental ERA in general:

- European Clean Transport Facility (ECTF): the EIB initiative to support investments targeting research, development and innovation in the areas of emissions reduction and energy efficiency in the European transport industry. Industrial actors in the field of environmental technologies can obtain support via this programme for own R&D, including development of research infrastructures (like in the case of ECTF support to Valeo group[87]).

84 European Commission (2009), FOURTH STATUS REPORT ON EUROPEAN TECHNOLOGY PLATFORMS HARVESTING THE POTENTIAL, July 2009.

85 European Commission (2009), Strengthening the role of European Technology Platforms in addressing Europe's Grand Societal Challenges Report of the ETP Expert Group, October 2009.

86 European Commission (2009), "Strengthening the role of European Technology Platforms in addressing Europe's Grand Societal Challenges", *Report of the ETP Expert Group, October 2009*"

87 http://www.eib.org/projects/press/2009/2009-148-france-valeo-research-projects-to-receive-loans-of-up-to-300-million-euros-from-the-european-investment-bank.htm

- Regions of Knowledge initiative: aims to support trans-national mutual learning and cooperation between research-driven clusters, bringing together regional authorities and development agencies, public research organisations, industry and other relevant stakeholders. Initiatives to improve and share research infrastructures are among the eligible activities[88].
- European Structural Funds: regions and Member States use the Structural Funds in a flexible manner to help meet their specific needs regarding development of environmental research infrastructures.
- Risk-Sharing Finance Facility (RSFF): aims to improve access to the EIB debt finance for participants (including environmental RIs and their funders) of European R&D projects. The list of priority areas for the RSFF includes: renewable energy technologies, biotechnology, engineering, manufacturing and automotive, information and communication technology projects, as well as European research infrastructures[89].

Besides the EU, Members States provide the bulk of funding for research infrastructures that operate at national level. These funds are usually channelled through research funding agencies, research councils, research infrastructure funding facilities, and general national R&D support measures (such as the R&D cluster programmes, pole of competence/excellence, etc).

4.5.15 Strengths, weaknesses, opportunities and threats

Strengths	**Weaknesses**
• Good accumulated resources in terms of existing research infrastructures. • Strong European interest and ongoing effort in further development of RIs including environment (via ERIC). • Openness of the environmental RIs towards participation of foreign researchers and external users (at least declared in their research agendas).	• Relatively small size of the environmental RIs, which might constitute a weakness if the RI is not able to attract enough funding for maintenance and development. • Coordination among the RIs in the framework of ERA-NETs and ETPs is not evident and needs improvement. • The networking activities of existing RIs can be further improved.
Opportunities	**Threats**
• Greater synergies between infrastructures and the relevant EU funded projects • Better coordination of activities among international research infrastructures (e.g. through ERA-NETs, ETPs and other national and international channels). • Larger involvement of international research community in environmental research and growing demand for environmental RIs.	• Spending cuts in national financing as a result of the economic crisis and the following decrease in the scale of RIs' operations.

88 http://cordis.europa.eu/fp7/capacities/regions-knowledge_en.html

89 www.eib.org/about/press/2007/2007-095-risk-sharing-finance-facility-rsff-contributes-eur-359-million-to-research-and-innovation-with-strong-focus-on-renewable-energy-technologies.htm

4.6 Dimension 5: Effective knowledge sharing

4.6.1 What is it about?

Sharing of knowledge is certainly embedded in many different forms of collaboration, varying from collaboration under FP to specific bilateral/multilateral collaboration agreements. The ERA ambitions in this respect are to improve the dissemination and exploitation of knowledge. In particular in the combined research area of environmental sciences, access to e.g. monitoring data from national sources is often indispensible for pushing research forward. This dimension covers the following aspects:

1. Involvement of society in research agenda setting.
2. Access of public to scientific knowledge.
3. Shared principles for cooperation between research and industry.
4. Simple and harmonised regime of IPR.
5. Open and easy access to the public knowledge base.

4.6.2 What does existing literature say about the adequacy of knowledge sharing and dissemination mechanisms in the field of environmental research to foster ERA?

The literature recognises the need for improving the knowledge transfer in European research institutions which is hindered by a range of factors, including: cultural differences between the business and science communities, lack of incentives, legal barriers, and fragmented markets for knowledge and technology[90].

The data that support the process of environmental policy decision making are often complex, ambiguous, dispersed across multiple monitoring networks maintained by different organizations, provided in many narrow technical papers and presented with jargon that is not clearly understood by the policy analyst.[91] The culture of science that generates and analyzes the data is very different from the culture of politics that uses the resulting information for decision making. Yet, environmental problems like climate change or water quality are not scientific problems or political problems alone, but interdisciplinary problems that require a unified science-policy solution.[92]

Following the Publication of the ERA Green Paper in April 2007, a Communication titled "Improving knowledge transfer between research institutions and industry across Europe" including voluntary guidelines for universities and other research institutions to improve their links with industry across Europe was issued. The Communication on knowledge transfer was followed up with a Commission Recommendation on the management of intellectual property in knowledge transfer activities (the

[90] European Commission (2007), "Improving knowledge transfer between research institutions and industry across Europe", Communication from the Commission

[91] Engel-Cox, J. and R. Hoff (2005), "Science-policy data compact: use of environmental monitoring data for air quality policy," *Environmental Science & Policy*, Vol. 8, pp. 115-131.

[92] Born, J., Boreux, V. and M. Lawes (2009), "Synthesis: Sharing Ecological Knowledge—The Way Forward," *Biotropica*, Vol. 41, pp. 1744-7429.

Recommendation) and the Code of Practice for universities and public research organisations (PROs) (the Code of Practice), which were adopted in April 2008[93]. The Recommendation and the Code provide a coherent framework for the management of IPR between PROs and the private sector.

While important steps have been undertaken to establish the adequate knowledge transfer mechanisms at the national level, there is a need to address the international dimensions of knowledge transfer and in particular to address the obstacles originating in discrepancies between national systems[94].

4.6.3 What environmental research science-industry knowledge sharing and dissemination mechanisms exist?

The science-industry knowledge sharing mechanisms in environmental research are in general are similar to the ones in other fields (i.e. collaboration, meetings, conferences, workshops, collaboration, co-publication, co-patenting, citation behaviour etc). The field of environmental sciences is very broad (and global in nature) and thus utilizes virtually all knowledge dissemination channels available for the modern scientific community. It, nonetheless, should be noted that environmental research puts high value on information collected from environment monitoring facilities. Thus, the importance of well established and easily accessible data sharing facilities has special importance for both scientists and the industry.

The composition of the FP programs is a good indication of the potential knowledge sharing among the partners involved. We observe that the conventional research actors (research centres) are most frequently involved, followed by the higher education institutions (mainly universities). Comparing the average number of participants (all kinds) in the FP6 and the FP7 projects, we observe that in both programmes such a number is much higher in the environmental research than in other areas. There is progress regarding the degree of the industry participation in joint environmental projects. It is on average lower than in other areas, but has grown between FP6 and FP7 (from 2 to 3 project participants on average).

In the network analysis of the FP participation data we observe that for the FP6 programme 10 most important institutions (public research centres which work as 'hubs' to other partners) represent 9 different countries. This is a strong indication of the established cooperation network, which is capable of going beyond the effects of a single cooperation project. These institutions have a good potential of becoming the main bridges for knowledge exchange flows between science and industry.

In an effort to create new science-industry collaboration poles, the European Institute of Innovation and Technology (EIT) has launched three major new innovation clusters, the so-called Knowledge and Innovation Communities (KICs), focusing on climate, energy and information technology. The KICs are envisioned as highly integrated, creative and excellence-driven partnership bringing together the players from education, technology, research, business and entrepreneurship in order to produce new innovations and new innovation models.

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93 http://ec.europa.eu/research/era/areas/knowledge/knowledge_sharing_en.htm

94 European Commission (2008), "Commission Recommendation on the management of intellectual property in knowledge transfer activities and Code of Practice for universities and other public research organisations".

4.6.4 *To what extent are ICTs used for knowledge sharing purpose?*

In previous questions we pointed out the special importance of environmental data sharing as one of the main knowledge exchange channels in environmental research. One of the conditions the European Research Infrastructures must satisfy is that they should be integrated, networked and accessed through the concomitant development of new generations of electronic communication infrastructures, both in Europe and globally. The RIs must be able to benefit from the ICT-based infrastructures such as Grid, computing, software and communications.

A number of the European research infrastructures contribute collected data to the environmental data centres of the European Environmental Agency (EEA).[95] The ESFRI roadmap contains as well at least one new infrastructure devoted to providing ICT-based services for data collection, integration and data depositary for the EEA.[96]

The ICT-based information resources like EnviroWindows of the EEA provide the means for knowledge sharing with industry by providing enterprises with electronic access to the resources about: Cleaner Production, Corporate Sustainable Reporting, Innovation and competitiveness, Integrated Product Policy, Material Flow and Waste, and Tenders, News, Investments.

4.6.5 *To what extent is knowledge transferred and used to create new products and processes?*

In total there are 14.618 patent families Worldwide identified in the combined area of environmental technologies. Based on patenting performance (patent families) of the top 200 patent assignees we see that Fraunhofer is leading in number of marketable inventions followed by CNRS. Besides the top-performers, patenting performance has remained rather low over the entire line. Compare to non-EU organisations, EU patenting performance is strong (e.g. University of California has 87 patent families, compared to 107 for Fraunhofer).

The next logical step in the knowledge transfer process is commercialisation of patented invention and actual introduction of the new product or service. Here an effective IPR-system must work along with the system of entrepreneurial financing and industry-science interaction. Such an interaction presents a challenge not only in environmental research, but in any other field of science.

Nonetheless the KIC initiative looks like a good step in direction of promoting science-industry collaboration in the field of environmental research. The activities of a KIC will be based on a monitored business plan with a clear focus on results and deliverables with targeted investment returns which is expected to ensure the quality and sustainability of their innovative projects.

4.6.6 *How many environmental science co-publications are produced and what is their share of total publications?*

The number of collaborative publications published by the European researchers has been increasing steadily over time (from 7.754 during 2000-2004 to 14.651 during

[95] http://www.eea.europa.eu/data-and-maps/data-providers-and-partners

[96] The IAGOS-ERI is one of the new European Research Infrastructures on the ESFRI Roadmap 2006 devoted to long-term observations of atmospheric composition, aerosol and cloud particles on a global scale.

2005-2009), although the number of domestic publications still prevails (around 70% of total number). This tendency is developing on the background of increasing total scientific knowledge production (the total share of co-publications remained around 30%).

The shares of intra-EU and extra-EU co-publications are 16.98% and 15.08% respectively, which highlights the relatively equal importance of cooperation both globally and inside the EU.

4.6.7 How many environmental co-patents are produced and what is their share of total patents?

In total there are 14.618 patent families identified in the combined area of environmental sciences from which 1.079 are identified as European. When comparing the share of co-assigned patents in the field of environment to that in Agriculture and Food we observe that this share is much lower in environmental research.

Nonetheless, for all environmental fields, the overall share of EU patents involving applicants from more than 1 country rose from 7.1% in the early 1990s to 12.1% in 2000-04. Extra-EU collaboration is relatively more important than intra-EU, as extra-EU-15 co-inventions accounted for 8.2% of total patents in 2000-04 and intra-EU-15 only 3.9%. However the trends in both indicators are very similar over time.

There is clear tendency towards more international cooperation when measured by the number of co-patents. As co-patenting becomes more and more active, it becomes crucial to work more towards unified patent protection rules in the EU and making it easier for research institutions to manage their intellectual property.

4.6.8 How is IPR managed in the field of environmental research?

IPR management is subject to general national and international rules, and is often depending on the institutional strategies. At the European level the institutions are advised to refer to voluntary guidelines for universities and other research institutions to improve their links with industry across Europe[97].

The Communication on knowledge transfer was followed up with a Commission Recommendation on the management of intellectual property in knowledge transfer activities (the Recommendation) and the Code of Practice for universities and public research organisations (PROs) (the Code of Practice).

The expert group on knowledge sharing emphasises that IPR provides an important mechanism for stimulating knowledge transfer in the field of environmental research. Furthermore, the IPR provide inherent incentives to researchers to take up new research topic and commercialisation initiatives[98].

When it comes to knowledge sharing, the ERA in the field of environment faces similar challenges as in other fields[99]. The most important of them is the necessity to overcome actual fragmentation in the IPR regime. While the initiatives toward harmonisation in this area are widely known, at the operational level (for example, when applying for a patent and in patent litigation) such fragmentation persists.

4.6.9 To what extent do SMEs participate in knowledge transfer and dissemination in the field of environmental research?

When looking at the level of European research projects we see that the SMEs play a visible role in a number of environmental research topics such as waste management

97 Ibid. 94

98 Ibid. 99

99 European Commission (2008), “Knowledge sharing in the European Research Area”, report of the ERA Expert Group.

and recycling, water saving and purification, energy saving and use, air purification, the development of environmentally friendly products and noise reduction, etc[100].

Industry, and mainly SME, participation in the FP-sponsored research collaborations has been increasing over time, although slightly and at a relatively low level. For example, in the core targeted environmental projects from FP6 one out of 11.2 participants was an SME. In the FP7 core environmental project this ratio has increased to one in 8.8 participants. For the non-core FP6 and FP7 projects the degree of SME participation is considerably lower at 5.4% and 5.2% respectively.

The SMEs can provide researchers with a necessary link to the market and can help in bringing out new products and services. According to the "SME Participation in FP7" Report (Spring 2009), 8.6% of the SMEs participating in the FP7 have reported their participation in projects related to the field of environmental research. The SMEs show interest in participating at a local scale in the environmental technology development initiatives, but the UK experience shows that that the impact of such activities is likely to remain rather limited without additional policy efforts at national level[101]

On the other hand, it has been estimated that the SMEs in Europe are responsible for up to 70% of industrial pollution in Europe[102]. Compared to this number, the rates of participation of the SMEs in environment related research appears lower than is desired and considered adequate.

It can be argued that stimulating further participation of the SMEs in environmental research is important due to two reasons. First, the SMEs comprise a considerable share of economic activity in developed and developing countries. Second, the SMEs are very flexible when it comes to introducing new technologies and at the same time have a preference for the most cost-efficient solutions, providing a good economic test for new inventions.

Additional developments towards improving SMEs participation in environmental ERA can be achieved by employing the measures outside the traditional STI policy instruments. For example, we see that consumer demand can promote such voluntary compliance approaches as the ISO 14000[103] standard, green labelling, and clean technology brands. The policy makers can join the forces with the market and encourage these practices as the means for environmental and resources management in the large firms and the SMEs as well.

4.6.10 What is the extent of SME participation in national, transnational and EU research programmes?

The industry participation in FP has been increasing over time, although slightly and at a relatively low level. And such a ration is even lower for the non-core research projects under both framework programmes. The SMEs most actively participate in the FP actions, which are specifically designed for them (for example, Research for the benefit of specific groups in FP7 with more than 60% participation rate). This is a positive fact, but it also points out that active SME involvement requires constant efforts, which has been recognised in the FP7 programme objectives.

According to the Erawatch European S&T policies inventory, virtually all European states have installed special national policy measures to promote SME participation in research

[100] http://ec.europa.eu/research/environment/index_en.cfm?pg=sme

[101] Peters, M. and K. Turner (2004), "SME environmental attitudes and participation in local-scale voluntary initiatives: some practical applications", Journal of Environmental Planning and Management, Vol. 47, pp. 449-473.

[102] Hillary R. In: Small firms and the environment: a Groundwork status report. Birmingham, UK: The Groundwork Foundation; 1995. p. 3–10.

[103] http://www.iso.org/iso/iso_14000_essentials

and industry-science relations (in the framework of innovation cluster, centres of competence and excellence measures)[104].

4.6.11 *What is the follow-up to Commission recommendation on the management of intellectual property in knowledge transfer activities C(2008) 1329105 in the Member States in the field of environmental research?*

The data or the factual information about the follow-up to C(2008) 1329 in the Member States in the field of environmental research is not available. Some indirect evidence is available in the Report of Van Eecke et. al (2009) to the European Commission[106]. In the survey of interested stakeholders, 73% of respondents either agreed or strongly agreed that non-binding codes of conduct regarding IPR ownership, in Member States that do not already have them, would have a positive effect on national IPR system.

Especially interesting in this matter will be the future report of the CREST/ERAC Working Group on Knowledge Transfer, which analysed information on the status and progress of national and Commission policies and initiatives to promote and enhance knowledge transfer along the lines of the Recommendation and Code of Practice.

4.6.12 *Strengths, weaknesses, opportunities and threats*

Strengths	**Weaknesses**
• EC has outlined a clear conceptual framework for knowledge transfer and dissemination in the ERA in the Code of Practice. • Introduced Code of Practice for research organisations which are in general found acceptable. • European environmental research institutions actively engage in knowledge sharing (supported by co-publishing and to a less extent by co-patenting statistics). • European research support programmes pay special attention to knowledge transfer, including participation of SMEs. • Environmental research is a part of open access pilot of EU.	• SMEs' participation in joint FP projects in environmental research is lower than in other fields. • SMEs' participation in joint FP projects does not appear to be proportional to their environmental impact. • The degree of co-patenting activities in environmental research is lower than in the comparable field of food and agriculture. • Other sources point at insufficiently implemented international framework for IPR protection in Europe.
Opportunities	**Threats**

[104] Erawatch Database.

[105] European Commission (2008), "Commission Recommendation on the management of intellectual property in knowledge transfer activities and Code of Practice for universities and other public research organisations", C(2008)1329, 10 April 2008

[106] VAN EECKE, P., KELLY, J., BOLGER, P. and M. TRUYENS (2009), "Monitoring and analysis of technology transfer and intellectual property regimes and their use", Report to European Commission.

• As more research institutions effectively follow the common knowledge transfer framework, it may lead to a jump in knowledge exchange activities and dissemination of research results. • The environmental issues attract growing attention among population, scientists, governments and investors. • The environmental issues and global challenges become more prominently present in the S&T and general policy agendas.	• Spending cuts in national financing as a result of economic crisis can lead to less resources being available for knowledge exchange in the field of environmental research.

4.7 Dimension 6: A wide opening of the European Research Area to the world

4.7.1 What is it about?

In a few sentences the purpose of national and European policies to promote ERA's opening-up to the world can be summarized as follows:

- Support European competitiveness through strategic partnerships with non-EU countries in selected fields of science and by engaging the best scientists from such countries to work with and in Europe.
- Enhance the production of knowledge and scientific excellence by enabling European universities, research institutions and firms to establish contacts with their partners in such third countries, thereby facilitating access to research environments outside Europe and promoting synergies on a global scale.
- Address specific problems that Third countries face, or that have a global character, on the basis of mutual interest and mutual benefit. It is clear that different ambitions related to different types of Third countries (industrialized versus non-industrialized).

According to our hierarchy of objectives, the sub-objectives here are:

1. Development of multilateral initiatives to address global challenges.
2. Stimulating participation of neighbouring countries.

4.7.2 What does existing literature say about the adequacy of international cooperation in the field of environmental research to foster ERA?

The role of international collaborations in fostering innovative capacities can not be explained in simple terms. In economic literature the effects of research collaboration are measures in terms of changes in productivity, absorptive capacity and knowledge spillovers.[107] Most of these effects are difficult to quantify. It is nonetheless known that that leading European countries like Finland, Sweden, Denmark and Germany invest more in international collaborations and gain competitiveness[108].

Regarding the effect of research collaboration in the ERA, it has been recognized that it has positive effects across all activities. Furthermore, in the field of environment researchers face global challenges, which can not be adequately addressed without pooling the efforts and utilizing the inter-disciplinary approach to cooperative research in the field of environment[109].

Experiences from the Swiss Priority Programme Environment SPPE (1992–1999) and the Swedish Foundation for Strategic Environmental Research MISTRA (incepted in 1994) which introduced clear interdisciplinary approach to their decision making shows that

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[107] Belderbos, R., Carree, M. and B. Lokshin (2004), "Cooperative R&D and firm performance", *Research Policy*, Vol. 33, pp. 1477-1492.

[108] European Commission (2008), "Opening to the world: International cooperation in Science and Technology", Report of the ERA Expert Group.

[109] Ibid. [67]

there is clear value added in such cooperation if organised optimally and allowing time for development of inter-disciplinary synergies.[110]

4.7.3 What are the leading FP Associated States in environmental research?

First results indicate the two out of five leading non-EU countries in environmental research measured by scientific publications are Associated States. The leaders are: the USA, Canada, Switzerland, Japan and Turkey. Switzerland has been identified as the leader based on patenting performance data.

Based on FP participation statistics (both FP6 and FP7) for the core environmental research projects, the leading Associated States are Norway, Switzerland and Turkey. By the totals of participations in non-core environmental research projects, the above group is joined by Israel as the leading country.

4.7.4 What national international research cooperation agreements exist?

The data on national R&D support measures from the ERAWATCH database provides us with a mixed picture regarding their openness to Third countries. The share of "Open" (both to the EU and the Third countries) national R&D support measures in the total relevant policy mix ranges from 0% to 100%. It is, nonetheless, evident that the environmental research policy initiatives in Member States tend to have mostly a national character. There are on average 44% of general R&D measures which allow for some involvement from Third countries and 31% of targeted environmental R&D programmes, correspondingly.

According to the information provided by the Erawatch European S&T policy inventory many measures welcome international projects, but often without financing from national sources. With regards to the research infrastructures, we observe on average 54% of environmental research infrastructures are open for participants from the Third countries.

At the bilateral and multilateral level, the majority of agreements registered by the DG RELEX in the field of environment concern the issues of information exchange and environmental safety. There are a number of bilateral and multilateral agreements, which are made with the purpose of promoting environmental research and protection in a particular geographic area (for example, Baltic Sea, Mediterranean Sea, Carpathians region). The bilateral agreements usually involve the neighbouring countries or trade partners with a considerable share of mutual trade flows.

In the Framework Programmes there are 22 international environmental ERA-NETs among which 16 ERA-NET carry out coordination action and 6 are directed at specific support actions. There are 6 environmental ERA-NETs, which also have participants from the Third Countries.

4.7.5 What non-European countries participate most frequently in EU and national INCO programmes?

Russia, China, India, and the United States are among the most frequent participants in international FP6 and FP7 environmental research projects. The most active non-European participants in the environmental INCO-NET programme are Azerbaijan, Georgia, and Kazakhstan. It should be noted that INCO-NETs in their current form carry a clear regional character. In the framework of the FP7 SICA the projects are oriented primarily at cooperation actions in Africa and South-East Asia.

[110] Pohl, C. (2005), "Transdisciplinary collaboration in environmental research," *Futures*, Vol. 37, pp. 1159-1178.

Bilateral S&T cooperation agreements with Third Countries have also always been crucial (for a detailed analysis of international cooperation under FP6 we refer to the report on international standing of the FP6[111]). Among 47 Special International Cooperation Actions (SICA) of FP7 there are 9 projects in the area of environmental research.

At the national level, besides the involvement in the FP and INCO thematic priorities, there a number of specific cooperation activities, national-level initiatives and international treaties have been introduced, mostly targeting the countries from particular geographic regions (Russia/NIS, Mediterranean partner countries, Western Balkans, and Developing countries in ACP, Latin America and Asia).

4.7.6 What role do non-European experts (from INCO countries) play in EU and national research programme/policy design/implementation?

The FP6 international standing report shows that the experts from INCO country play a role (5% from the number of FP evaluation experts in 2007 and 4.4% in 2009) as participants in joint international research projects and programmes. The influence of INCO experts on policy design is difficult to generalize and depends on the roles of individual experts in different individual projects.

As one of the ways to optimize the role of non-European experts in EU and national research programming we can suggest to involve such experts in every initiative, which spans beyond the borders of the EU and touches the environmental situation and interests of neighbouring countries. Furthermore, the input of experts from countries facing similar environmental challenges is valuable as well.

4.7.7 What extra-European environmental researcher mobility schemes exist?

Under FP6 MCA actions, there have been 107 projects (mobility actions) related to environmental sciences and technology. Under FP7 MCA actions, there have been 84 projects (mobility actions) related to environmental sciences and technology (the total number of researchers participating in these projects is not available). Participants from extra-European countries are present in both FP6 and FP7 mobility actions. Participants from extra-European countries are presents in a number of ERA-NETs.

There exists a small number of national policy programmes allowing for international mobility of researchers from extra-European countries (according to Erawatch European S&T policies database). The issue of mobility of extra-European researchers raises several sensitive issues: competition with domestic scientists, financing, and brain drain. Especially in the case of the latter, the researchers' mobility is not necessarily beneficial for all participants. The ways to avoid and minimize such problems can be found in development of common research priorities between countries, where mobility of researchers has a clearly defined role and all the aspects of researcher mobility (scientific, economic and social) are taken into consideration.

[111] "Assessment of the international standing of the 6th Framework Programme", Final report to the European Commission, DG Research, 2009.

4.7.8 *What national environmental research funding is directed towards global environmental challenges?*

Government Budget Appropriations for R&D[112] (GBAORD) provide a good indication of national investments in different socio-economic areas. As mentioned elsewhere in this report, two environmental areas were investigated, the area of 'Exploration and exploitation of the Earth,' and 'Control and Care of the Environment'. In 2007, the EU-27 countries together invested about 1.193 million EUR in R&D in the area of 'Exploration and exploitation of the Earth' (+38% compared to Y2000) and 1.920 million EUR in the area of 'Control and care of the environment' (+2.84% compared to Y2000).

At the national level United Kingdom, Germany and France and the leaders in terms of the GBAORD devoted to environmental research priorities (both 'Exploration' and 'Environment' areas) spending between 2000 and 2007 on average 394 million EUR, 733 million EUR, and 454 million EUR correspondingly.

The new Member States find themselves in the lower part of the spectrum when it comest to the volume of environmental GBAORD. But considering the share of environment-related priorities in the average budget appropriations during the period 2000-2007 we observe that such a share is highest in Hungary, Lithuania, Bulgaria and Estonia.

4.7.9 *Strengths, weaknesses, opportunities and threats*

Strengths	**Weaknesses**
• EC has outlined a clear concept for international cooperation with Third countries. • The FP-participation network provides adequate conditions for cooperation with Third countries. Over time, Third countries are increasingly involved. • SICAs - specific funding scheme to encourage third country participation	• Insufficiently implemented international framework for IPR protection and researchers mobility with Third countries. • Limited national research mobility schemes targeting Third countries. • Limited coordination between Member States. • Many multilateral agreements and programmes are set up in regional and not national/global context.
Opportunities	**Threats**
• Greater mutual involvement of international community and the EU in research activities in the field of environmental research as means of addressing global challenges. • Better tailor the type of collaboration to the type of Third country that is being dealt with (industrialised versus non-industrialised).	• Spending cuts in national financing as a result of economic crisis can lead to less resources being available for international cooperation with Third Countries.

[112] GBOARD provides public funding figures and no expenditures and may include international cooperative initiatives like the European Space Agency (ESA).

5 CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

5.1.1 In general

The strategic objective of this study was to 'promote' the European Research Area through the development of a thorough knowledge base and the assessment of progress made and challenges lying ahead. The operational objectives directed us towards the identification of barriers and success factors, towards the appreciation of progress on each of the ERA dimensions, and towards the role of geographical disparities and future actions needed, in order to improve the future ERA formation in the area of environment.

A multitude of data, indicators and opinions have been gathered (over a period of 6 months) in order to answer the 52 research questions, divided under each of the 6 ERA dimensions. A large number of Member State representatives provided their support, and emphasized the need for a reliable and up-to-date database and monitoring system in order to support further policy development in this area. This was a first good indication that ERA-progress in environmental sciences is indeed an issue of concern and importance to those involved in policy making.

Below we present a number of introductory high-level conclusions, followed by a series of more detailed conclusions at the level of the individual ERA-dimensions.

1. In environmental sciences and research, both at the national levels and with respect to the EU ERA promotion instruments, there are different indications of **progress towards 'more' ERA**. Since the year 2000, and also based on the transition from FP6 to FP7, we can see a positive evolution at many different levels and parameters. Nevertheless, barriers remain, and this mainly at two levels.

    1.1. The first level, concerns the **differences between countries (EU and associated countries) in the legal frameworks** surrounding education, research and innovation (e.g. on granting procedures, funding rules and cycles, on education and use of foreign languages, on institutional framework conditions etc.). This creates several obstacles for collaboration and further integration at the operational levels.

    1.2. The second, concerns the almost 'natural need' for countries and research institutions to **compete**, **rather than to collaborate**, and this in view of an increasing globalized competition for funds. These barriers, however, can be overcome.

2. Further development of 'ERA' in environmental sciences and research almost by definition depends on the **will** of the **Members States** and **associated countries**, and the **leading R&D institutions**. It is important that political leadership shows the way forward.

3. Our analysis suggests that **EU ERA promotion policies and instruments** have clearly facilitated the development of ERA in environmental sciences.

3.1. Part of the progress towards ERA in environmental sciences, is indeed also triggered by what we could refer to as the **'horizontal and global nature'** of the field, and the increased awareness that only an orchestrated and truly global approach will be effective in dealing with the challenges lying ahead. Nevertheless, this natural tendency also has to be facilitated and supported, and this is where the EU promotion schemes come in quite successfully.

3.2. The success of FP6 and FP7 (e.g. ERA-NETs, collaborative and integrated projects, Marie Curie Actions, European Technology Platforms) have had a clearly **catalytic** and **exemplary function** for the development of R&D policies of many Member States and research institutions. Stimulation and facilitation of participation in FP6 and FP7 has become a priority in national R&D policies.

4. Although the general notions underlying the ERA strategy and ambitions are commonly understood and accepted, it seems still not clear how **ERA translates** into concrete **operational objectives** for R&D institutions and even for lower levels of governance and policy making? Underlying study did shed some light on this, without having the opportunity to be exhaustive, but more work will be needed in the near future. The ERA 'intervention logic' (i.e. developing a clear hierarchy of objectives and actions) needs to be fully developed in the short run.

5. The development of a true **ERA is a long term endeavour**. We see already many positive indications, but a lot of new and promising initiatives (e.g. Joint Programming initiative, or the Knowledge and Innovation Communities) have only recently been launched and their contribution cannot be fully judged at this point in time. Future studies could/should look into the role of these relatively new instruments.

6. The study team faced a number of analytical difficulties due to **data availability and validity** problems; although the general analysis and diagnosis is reliable, care is needed when citing specific (disaggregated) data and or indicators.

6.1. First of all, the study team faced the problem of **lacking disaggregated data**, specifically at the level of the environmental research subfields. The relevant data sources did not provide the opportunity to disaggregate down to the level of subfields meaning that hardly any conclusions could be drawn at this level, and several research questions could not be answered precisely enough.

6.2. Secondly, existing data sources could **not (always) be externally validated** (by e.g. representatives of Member States and associated countries), while the general impression was that several of our data sources (like the ERAWATCH national R&D policy inventory) were not always up-to-date and correct. It is therefore important to treat precise pieces of information and indicators with care.

5.1.2 At the level of each of the ERA-dimensions

7. With respect to the dimension '**Well-coordinated research programmes and priorities**':

7.1. The following main indications have been captured:

- Public investments in environmental R&D are increasing over time and are now (2007) higher than in the US (per inhabitant).

- At this moment a reliable assessment of private investments in environmental R&D is not possible due to the absence of reliable data. The dynamics of employment growth in the eco-industries (with rates above general economic growth) provides indirect indication that there is an above-average growth trend in this field.

- A large share of R&D support measures is 'open' to foreign researchers, but this does not equal the free flow of research funds across borders. This is still not common as a result of, among other, legislative barriers and political persistence towards national priorities.

- Environmental ERA-NETs have led to more openness, coordination and cooperation between national R&D programmes and priorities (large number of successful ERA-NETs) in specific areas. Several Joint Calls have been developed, but funding modalities remain 'national'. Participants value the development of joint evaluation procedures.

- There are several strong and active environmental ETPs with a strong structuring/mobilization effect between research and industry. These ETPs have mirror groups in many Member States and some of them have managed to develop into Joint Technological Initiatives.

- Joint foresight exercises for agenda setting are not common, regardless the global nature of environmental problems. Nevertheless, research priorities among Member States and the EU seem to be converging significantly if we look at the broader research priorities.

8. The involvement of multiple stakeholders is increasingly becoming a common practice (through the ETPs, ERA-NETs, KICs, etc.) just as Joint Programming (yet at its infancy), joint implementation and evaluation. Research funding, however, remains a mainly national issue. Harmonisation of research governing principles between selected countries is slowly but surely taking place, triggered by EU initiatives and based on the bottom-up processes (e.g. through experiences of programme managers gained in the ERA-NETs).

9. With respect to the dimension **'An adequate flow of competent researchers**':

   9.1. The following main indications have been captured:

   - There is growth in the shares of graduates in environmental protection in most of the Member States and the EU-27 on average.

   - There are plenty of mobility support measures (although not dedicated to environmental sciences) at national and, also, the regional level. Although no systematic study on the effects of these measures is available, mobility levels have increased over time as a result of these measures. EU support schemes (like EURAXESS, MCA, Erasmus Mundi, etc.) are successful and are increasingly used by researchers in 'smaller' environmental subfields.

   - Compared to other science fields, researchers in Natural Science are indeed very mobile (students as well). No specific information was available for environmental researchers. At the same time, barriers remain (labour market and immigration). US are a preferred destination for researchers.

   - There are certain concerns among representatives from new Member States regarding the 'brain-drain' inducing effects of international researcher mobility. 'Battle for talent' is mainly driven by national interests and often takes place at the expense of the less developed countries.

   9.2. Geographical mobility of researchers (in natural sciences), is significant although barriers remain. Mobility between disciplines and public/private sector is not that common which makes knowledge sharing and industry-academia collaboration difficult. EURAXESS seems to be a good platform, but exact data on e.g. open announcement of job openings at European research institutions are not available (to our knowledge). There is a gender balance among researchers in

the environmental sciences. The single labour market is still under development, as research institutions do not have sufficient autonomy to move faster. Despite visible progress, challenges remain.

10. With respect to the dimension '**Excellent research institutions**':

10.1. The following main indications have been captured:

- Europe has leading environmental research institutions that can compete at global level.

- EU support channels/instruments (ERA-NETs, KICs, Networks of Excellence, and other FP-instruments like collaborative projects) have a positive effect on network building and collaboration across borders.

- Leading institutions combine disciplines and expertise, and are leading on many 'parameters'.

- Based on the analysis of networks of collaboration, we see and suspect a lack of 'strategic' collaboration among the leading European environmental research institutions.

- The balance between competition and collaboration among leading European environmental research institutions is tipping towards competition.

10.2. There is clearly excellence among EU environmental research institutions and collaboration is increasingly becoming 'virtual', with research carried out at the partners' location, while having joint management and coordination facilities and with a clear joint 'brand'. Creation of such institutions is thereby triggered by the various FP-instruments and project types. Collaboration with industry remains challenging, as the SMEs still play a marginal role and are underrepresented as a group.

11. With respect to the dimension '**World-class research infrastructures**:

11.1. The following main indications have been captured:

- Strong EU support to development European research infrastructures. The ESFRI roadmap and related actions made a clear difference and had a large impact as a supporting mechanism for a coordinated effort to expand the environmental research infrastructures. The Community legal framework for a European Research Infrastructure Consortium (ERIC) provides favourable conditions for further development of research infrastructures in environment and other areas.

- In environmental research there are good accumulated resources in terms of existing research infrastructures. The small size and limited funding base of the majority of environmental RIs gives some reasons for concern about their sustainability. Even when such facilities are well developed and funded for their size, being small makes them vulnerable to possible cancelation in case the major funding agencies decide to cut their expenditures. This weakness can be mitigated by promoting more active cooperation among them.

- There is 'openness' of the environmental RIs towards participation of foreign researchers and external users, but in practice this is not straightforward due to limited available financial support. RIs are well integrated and networked when looking at project participation data. There

is a strong interest from international researchers in European research infrastructures.

11.2. Based on the above presented indications, integration and networking of infrastructures seems to increase, i.e. judged on the basis of project involvement in the FP (although coordination among the infrastructures themselves remains a point of attention). The accessibility to environmental research infrastructures also seems to be quite high, both inside and outside Europe.

12. With respect to the dimension '**Effective knowledge sharing'**:

12.1. The following main indications have been captured:

- EC has outlined a clear conceptual and legal network for knowledge transfer and dissemination in the ERA. A Code of Practice was introduced for research organisations, which is in general found acceptable. Practice however has still to follow.

- Leading European research institutions actively engage in knowledge sharing with other (often non-leading) institutions (based e.g. on co-patenting and co-publishing statistics). However, the intensity of e.g. co-publication activity is less high than in the field is of Agriculture and Food.

- The analysis of the networks of collaborating organisations in FP-projects reveals that there is knowledge sharing beyond the borders of one cooperative project. A number of large research institutions fulfil the role of 'hubs' and bring together various international actors in different FP-projects (often these institutions are also well-capable of coordinating large FP-projects).

- The share of participating SMEs in the EU-funded environmental research projects is below the desirable level but still close to the average SME participation (12,5% of all participants) in other scientific domains when comparing FP7 participation in core environmental projects (11,4%). The share of the SMEs in the non-core environmental projects is even higher (19,1%) than the average for other domains.

- When talking about the regulatory environment for knowledge exchange, the administrative burden and high costs related to EU-patenting (still fragmented IPR system) do function as barriers. Similarly, in relation to researcher mobility, another form of knowledge exchange, there are also several barriers that remain and make it difficult for researchers to work in other geographical places or in other sectors (e.g. industry).

- The extent to which society is actively involved in the research agenda setting could not be systematically analysed.

12.2. Based on the above presented indications, several of the sub-objectives related to this dimension are showing positive developments. There are shared principles for cooperation (although implementation in practices has still to prove success/failure), open and easy access to the public knowledge base is in theory reality, and society is increasingly involved in research agenda setting, but precise figures are lacking. With respect to this dimension it seems that some progress has been achieved but that at the same time it has to be recognised that it is too early to grasp the entire picture.

13. With respect to the last dimension '**A wide opening of the European Research Area to the world'**:

13.1. The following main indications have been captured:

- EC has outlined a clear conceptual and legal framework and a strategy for international cooperation with Third countries. FP7 is more open and Third countries are participating more than before.

- European research institutions see benefits in international cooperation with Third countries and actively involve them in cooperative activities and programmes. Third countries are not a homogenous group. Thus, a diversification strategy is needed.

- Benefits from collaboration are often unequal (especially in relation to mobility of researchers).

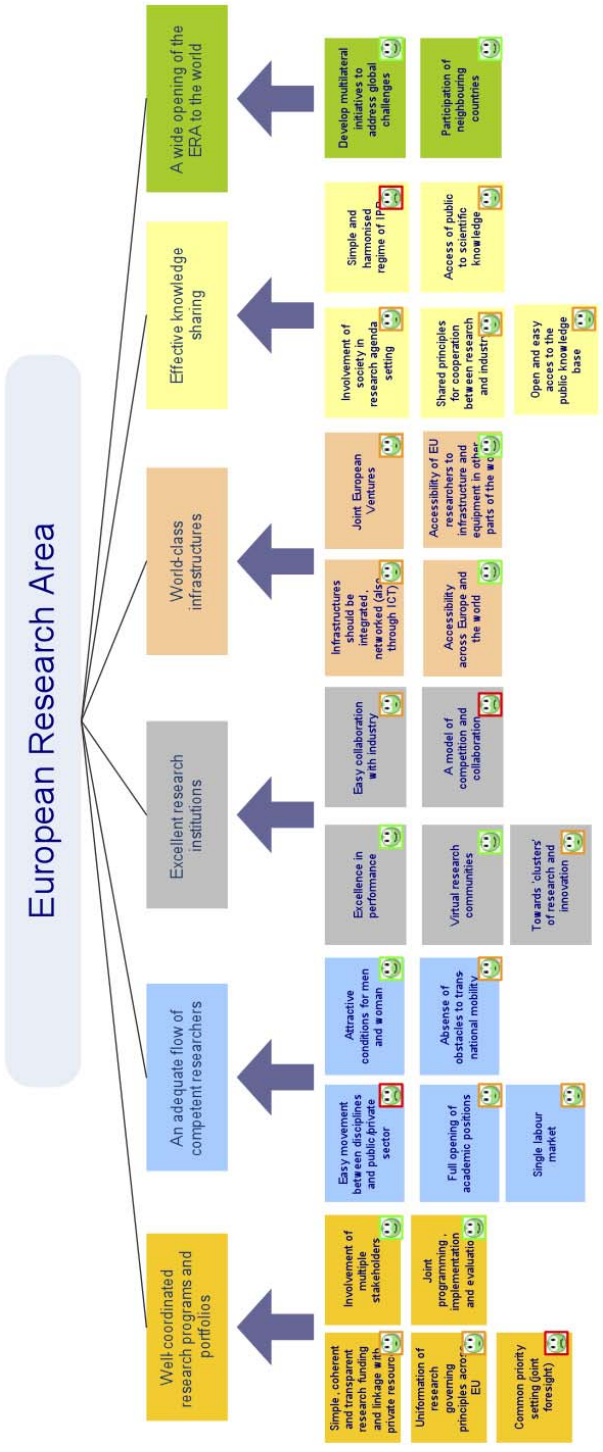
- While a number of active cooperation networks exist (often having a long history), an effort should be made to avoid duplication of efforts and unnecessary competition among such networks. The institutions in the role of 'cooperation hubs' should be encouraged to develop closer collaboration links. Comment: What about the competition /collaboration as part of international cooperation?

13.2. Based on the above presented indications, we can see that the sub-objectives under this dimension are increasingly realised, despite the fact that there are optimizations needed. There are plenty multilateral initiatives to address global challenges, and for neighbouring countries to participate in different EU schemes. As a consequence, it seems that significant progress has been achieved but that further optimization is needed.

Below we present a visualisation of the main conclusions in terms of progress on of the relevant dimensions and sub-objectives.

The overview is based on the hierarchy of objectives. In order to visualise the progress towards the ERA we use symbols. The 'red' (sad) face () indicates low/few indications of progress whereas the 'green' (happy) face indicates significant indications of progress (). The 'orange' () rather neutral face indicates that some progress has been made, but that there are additional efforts needed in order to move towards the ERA-ambitions.

Figure 2: Summarizing overview progress towards ERA in environmental sciences



5.2 Risks for the development of ERA in environmental sciences

In the previous sections we have systematically identified the different threats that are related to further progress towards ERA in environmental sciences. Below we present the most important risks.

- The first most evident risk factor lies in the general **economic climate**. In case the economic situation worsens (an example of such a development we have had a chance to experience in recent years), this will drastically reduce the amount of resources available for international R&D funding in environmental sciences. If such a downturn takes place, this may lead to a cut back in international commitments and the subsequent reprioritization in favour of national research and development agenda's.

- Driven by **self-interest** (and perhaps 'excused' by national legislation) the Member States could maintain barriers to knowledge exchange and/or researchers mobility in order to stay 'competitive'. For example in the area of researcher mobility, we see that the 'battle for talent' is not 'fair' for several groups of countries (e.g. new Member States). The countries with leading research institutions in environmental sciences will have an advantage over the countries that are still in the phase of developing capabilities. In the long term this may jeopardize the support and commitment of these countries to the ERA Vision.

- Another major risk to the development of ERA in environmental sciences but also in other fields is the **lack of clear and visible political commitment** and/or public support at different levels. For example, it is only consistent with the logic of subscribing to the ERA objectives, to give sufficient autonomy to research institutions and universities so that they can operate freely inside and outside the ERA.

- Finally, ERA should not remain a **high-level political issue/ambition**. We have already referred to the many 'grassroots' initiatives taking place at the level of single institutions, often because of necessity. It is important that initiatives towards the ERA can be undertaken at various levels (also regional and even sub-regional. Awareness creation and empowerment are thus essential.

5.3 Recommendations towards the future

5.3.1 At a strategic level

1. The benefits of ERA (when clearly identified and defined) should be repeatedly **communicated** to all levels of governance and all stakeholders involved. ERA should not remain a vague political ambition but should be made very specific (see also recommendation on future research). Monitoring of ERA progress could/should also be a component of the evaluation of country specific progress towards the Vision 2020 and the Innovation Union objectives.

2. This study has shown that there are **field-specific elements** that need to be taken into account when judging ERA progress in individual fields. ERA, although it seems like it, is not a homogeneous concept at all. Based on the 'variable geometry' thinking it seems important to focus on particular aspects (dimensions) of ERA in different fields. For example, in Environmental sciences, there is almost a natural 'need' to tackle **global challenges** on a worldwide scale and thus to combine efforts

and join investments, also in R&D. It seems therefore interesting to study the extent to which individual research fields could/should contribute (and how) the achievement of the overall ERA objectives.

3. **Ownership** creation and support for ERA on the local levels is essential. It should be recognised that moving towards the ERA in the field of environmental sciences largely depends on so-called 'grass root' initiatives, for example, cross regional and cross border collaboration. It is important to facilitate these grassroots initiatives in a flexible way. This needs **policy orchestration** between national and regional levels, between different DGs inside the European Commission (e.g. DG REGIO and DG RTD) etc. Further progress towards ERA should, moreover, be driven largely by bottom-up initiatives.

4. In line with the previous, as ERA is indeed a multilevel objective, it is essential to avoid fragmentation (of all available sources of funding) in achieving the objectives. This is in particular the case for SME-support, which is offered at various levels (EU, national, regional) and under different modalities and tools. Also at the level of European support, there is danger of fragmentation as there are different funding instruments available (CIP, FP, LIFE+, INTERREG, EUREKA, etc.); moreover, information to SMEs is also offered through a variety of channels (NCP for FP, NCP for LIFE +, EuroInfoCenters for CIP, etc.). An integrated **multi-instrument approach is therefore advisable, based on intensive coordination** at EU and MS levels.

5.3.2 At an operational level

Below we present a number of more 'detailed' recommendations with respect to each of the ERA dimensions in environmental sciences.

5. With respect to the dimension '**Well-coordinated research programmes and priorities**':

   5.1. Stimulate the implementation of Joint Foresight exercises (including joint impact assessment and monitoring) between leading EU environmental research institutions in order to ensure **'strategic' collaboration**. It is important to combine strengths and to share similar (or the same) challenges. These foresight exercises should however go along with common action plans and joint research (in analogy to the ETPs).

   5.2. EU Environmental Research is a quite **policy oriented** research. Building ERA in this domain means building capacities for answering "societal" issues at EU (and Global) level. Foresight and prospective exercises should include all stakeholders: policy makers from different policy areas (Research & Environment, Agriculture, Food and Maritime Affairs), environmental research institution, scientific experts, National Funding Agencies, NGOs, Think Tanks, and of course the Economic actors (e.g. ETP). "Round table" or "science meets policy" meetings (meeting of representatives of MS ministries of environment and research and EU DG ENV and DG RTD could be renewed and broadened.

   5.3. In the logic of **'smart specialisation'**, and as a part of the previously discussed foresight exercises, is also important to map expertise and strengths at EU-level, and to try to arrive at logical divisions of expertise development in the future, in order to tackle the major (societal) challenges. This would be essential in order to avoid duplication of efforts in the race for building up competitiveness and research excellence. For example, new Member States

could be given the opportunity to build up a curriculum in novel areas, rather than trying to duplicate already available expertise.

5.4. Stimulate cross border research funding by developing specific **'economic' stimuli** to this end. A very practical impulse could be to develop financial mechanisms to make cross border funding possible and attractive (e.g. through taxation impulses). At a more strategic level, this type of 'opening' could part of the periodic monitoring of progress of Member States towards the EU 2020 strategy and the underlying ERA-ambitions. The ultimate 'end' of this measure is not to boost cross border funding, but rather to allow for the best expertise to be funded in Europe, regardless the nationality. Of course, full coordination is needed here with existing mechanisms like the ERC and the EIT.

5.5. In parallel with developing of additional economic stimuli, the policy makers should adopt an open mind attitude towards existing market incentives, which **promote environmentally friendly and responsible business behaviour**. Green labels, environmental standards with voluntary compliance, corporate responsibility programmes, and other measures of this kind should be taken on board in the existing and new policy instruments. The Single Market initiatives are essential in this respect.

6. With respect to the dimension '**An adequate flow of competent researchers**':

6.1. As we have indicated above, several studies have pointed out **skill shortages** on various levels and within various environmental subfields. Skill shortage, or mismatch, is a major barrier towards mobility, mainly cross-sectoral mobility (industry – academia). It is important to make a good inventory of these skill shortages (threats) and mobilize the right actors, academic organisation, industry representatives. The environmental ETPs (like all ETPs) do have a mandate this respect and could be called upon to present a diagnosis and a roadmap towards tackling this problem.

6.2. In light of the previous recommendations, it is also important to carry out joint reviews and analysis of education programmes and existing mobility schemes for the subject of their better use towards **bridging the identified skill gaps**. If ERA is supposed to contribute to EU's competitiveness of environmental industries, there is a responsibility to take in terms of availability of sufficient and well-educated researchers and workers. Again, the environmental ETPs could be mandated to take the necessary initiatives in this respect.

7. With respect to the dimension '**Excellent research institutions**':

7.1. Investigate **'strategic' collaboration possibilities** among leading European environmental research institutions not only at the level of individual research institutions, but also at the level of network and/or national programmes in order to avoid unnecessary duplication. There are again different platforms where these discussions can take place, like LERU, EARTO, and EIRO. Se also recommendations 5.2 and 5.3.

7.2. **'Showcase' the leading EU environmental research institutions** in order to increase Europe's attractiveness as a destination for mobile researchers. Europe has a number of global players that could be showcased abroad in order to attract researchers to Europe.

8. With respect to the dimension '**World-class research infrastructures'**:

8.1. Create more synergies and collaboration between research infrastructures and their activities. At this moment we observe a large number of relatively small environmental research infrastructures that are comprised by individual research facilities. There are very few of them, which are represented by already networked entities at least at the national level. It is therefore important to stimulate collaboration among environmental EU infrastructures by considering **international complementary networks** as an important criterion in the take-up in the ESFRI roadmap.

8.2. The **synergies** between infrastructures can be enhanced by coordinating the RIs' research plans and priorities at international level as part of joint programming initiatives and ETPs. See also recommendations 7.1, 5.2, and 5.3.

9. With respect to the dimension '**Effective knowledge sharing'**:

9.1. Carry out a **detailed analysis on the reasons why the large numbers of SME support measures**, do not lead to higher participation rates (e.g. through a number of case studies or again 'round table' discussions on this topic). Perhaps there is a need for more dedicated measures particularly designed for the environmental SMEs. It is important first to understand well the reasons before taking any corrective actions and/or developing new measures. Again, as ETPs have a mandate in this respect, they could be stimulated to take this issue forward.

9.2. To this end, it might be necessary to design specific stimuli to involve SMEs in environmental research programmes (as, for example, involving them in field tests of new environmental technologies) – see also general recommendation number 4. This is important in order to reduce the environmental impact of the SME group. Having SMEs involved in development of technologies is a good way to **decrease the 'time to market' for new environmentally friendly products and production processes**. One has to be selective here, that is clear, and focus on those SMEs that have the potential to develop and enter new markets if needed. Again, the voluntary environmental standards compliance and corporate responsibility issues can be used to **promote participation of the SMEs in environmental ERA as a part of their business strategy**.

9.3. Development of an effective implementation of the **common knowledge transfer framework** may lead to a jump in knowledge exchange activities and dissemination of research results. As we see that all the necessary documents and agreements are in place, it is the matter of effective implementation to bear the actual results of better knowledge sharing. Therefore, it is advised to establish actual practices for knowledge exchange in accordance with the EC guidelines and Code of Practice.

9.4. Finally, the increasing involvement of society (and knowledge sharing towards society) in research programming is a good process that needs to be continued. Especially in the area of environmental sciences, it is important to **emphasize the societal dimension** and to communicate to the society at large, the results and progress.

10. With respect to the last dimension '**A wide opening of the European Research Area to the world'**:

10.1. Encourage an **open dialogue** on environmental issues among all involved stakeholders. When discussing the policy issues addressing global challenges it

must be encouraged to consult relevant experts from all Third countries: both those which are affected by the policy initiative in a particular region and those from other parts of the globe facing similar challenges (for example a policy discussion or a research project with regard to addressing rising sea level in the Netherlands could benefit from the opinions expressed by the experts from Bangladesh).

10.2. The similar principles must govern the process of international collaboration. The global nature of **environmental challenges must have a higher priority than political, economic and cultural drivers for cooperative research** in the field of environment. The regulatory bodies must become flexible enough to accommodate these principles in their practice (most importantly funding mechanisms, international mobility of researchers and openness of research infrastructures to the users from Third countries).

5.3.3 On monitoring and data availability

11. On the way towards development an effective environmental ERA monitoring framework we suggest that a limited number of indicators are used which nonetheless reflect the most important aspects of the ERA's progress in the field of environment. Among the indicators used in this study we highlight the following six groups:

    11.1. Indicators on **ERA-NET activities**, such as joint calls, activities with common pot financing, virtual common pots, etc.

    11.2. Indicators on **mobility of researchers** (< and > 3 month stays) in the field of environmental sciences.

    11.3. Indicators reflecting activities and **investment in environmental Research Infrastructures** and their networks.

    11.4. **Degree of openness** of national research institutions and infrastructures to participation of foreign researcher.

    11.5. Indicators on knowledge sharing activities reflected in the **co-publication and co-patenting** statistics.

    11.6. The volume and direction of the **cross-border R&D funding flows** among the EU, Associated and Third countries as an indicator for 'R&D FDI' in the field of environmental research.

12. In collaboration with Eurostat, it is recommended to look further into the possibilities of **data provision at the level of individual subfields** (disaggregated). For example, during this study this was a major problem faced.

13. It is strongly recommended to develop a common **classification framework** for environmental research fields and environmental technologies that are compatible across various European information collection platforms (such as Eurostat, FP, ERAWATCH, etc.) Having such a compatible definition system will greatly facilitate comprehensive monitoring, analysis, and evaluation of different aspects of environmental ERA.

14. There are particular steps possible to obtain better data reflecting **private investments in environmental research** and environmental technologies. Many Member States in their regulation have fiscal measures (such as tax credits and exemptions) towards investments and expenditures on environmental research and environmentally friendly technologies. Collecting these data from the national fiscal authorities will provide a good source of information about private financing of environmental research. This could be taken up in collaboration with Eurostat.

15. Regarding the aggregated expenditures posts (such as financing of the RIs, joint bilateral and multilateral research programmes with or without EU participation) it is important to provide where possible the **shares of the national, international and the EU financing**.

16. Concerning the number of non-nationals as staff of universities and research organisations, an important indicator, it is recommended to develop the conceptual framework needed and to perform a baseline measurement.

5.3.4 Future research

17. In hindsight, underlying study could/should also have been structured slightly differently. A lot of time and efforts has been put in the data collection process (as a result of the problems described earlier), whereas **more focus** earlier on in the process would have benefited the analytical and policy relevant work. However, in order to do so the following recommendation has to be implemented as well.

18. Monitoring of ERA developments in environmental sciences is becoming increasingly important in view of the horizontal and global nature of this field, and more in general, the importance of closely following-up the realisation of the EU Vision 2020 and the Innovation Union. As we have mentioned, the general notion of ERA is well-accepted and understood, but there is a need for a 'translation' to more operational objectives and targets. What does progress towards ERA imply? Future studies should provide sufficient time to carry out a so-called '**logical framework analysis'**, where a hierarchy of objectives is developed and linked to specific activities. This should be done in a series of workshops with Member State and Associated country representatives.

19. An important element in the discussion on ERA progress and the role and responsibilities of the various actors therein, lies in the '**valued added'** of moving towards the ERA. Also in environmental sciences, it is essential to have a good understanding of and insight in the benefits for Member States and Associated country of actively working towards the ERA objectives. To this end, a study focusing on the benefits of working towards the ERA for individual Member States and Associated countries could be performed. The question: "what is in it for us?" is a very relevant question and should be answered in order to convince policy makers to move on.

20. For future research, it is important to get further insight into the degree to which general assumptions also apply to environmental sciences. For example, do environmental researchers display similar mobility rates as other researchers and are they confronted with the same barriers? As a new EU study on mobility will be launched soon by DG RTD, it is important to foresee **detailed enough classifications** allowing for specific analyses of environmental researchers.

ANNEX I. TERMS OF REFERENCE

Terms of Reference for a specific contract on
Framework Contract BUDG O6/PO/01/LOT 3

The impact of European policy

on the development of the European Research Area (ERA)

in the areas relevant to the Environment

(including climate change)

April, 2009

The impact of European policy on the development of the European Research Area (ERA) in the areas relevant to the Environment (including climate change)

Terms of Reference (TOR)

PURPOSE OF THE STUDY: the European Research Area in the field of Environment

The overall purpose of the study is to promote the European Research Area (ERA) in the field of environmental research through a thorough knowledge base and assessment of progress made and challenges ahead.

In a changing world characterised by the accelerating globalisation of research and technology and the emergence of new scientific and technological powers, the ERA is more than ever a cornerstone for a European knowledge society. Such a society is one where research, education, training and innovation are fully mobilized to fulfil the economic, social and environmental ambitions of the EU and the expectation of its citizens.

The EU research Framework Programme (FP) is explicitly designed to support the creation of ERA.

The ERA concept combines: a European "internal market" for research where researchers, technology and knowledge freely circulate; the effective European level co-ordination of national and regional research activities, programmes and policies; and the initiatives implemented and funded at European level.

The public consultation on the ERA Green Paper[113] and the Commission's analysis of the outcome of this and suggested way forward as well as the report by DG RTD established Expert Group on ERA rationale[114], the Council of the European Union (EU), adopted on 2 December 2008 a Common 2020 vision for the European Research Area[115]. This is part of the Ljubljana Process of governance of ERA launched by the Commission and the Council on May 2008. In addition, a recent Court of Auditors report[116] noted that a more explicit intervention logic in future FP design will lead to more focussed and better structured programmes. Additionally, the recent evaluation of FP6 [117] makes several recommendations to improve the impact of the FPs. Finally, the ex-post impact assessment of FP6 sub-priority "Global Change and Ecosystems" [118] identified the progress on ERA in different areas of environmental research.

The ERA Green Paper as well as the Common 2020 vision for the ERA identified a number of non-sector specific areas (realising a single labour market for researchers; developing world-class research infrastructures, strengthening research institutions; sharing knowledge, optimising research programmes; priorities and opening to the world: international cooperation) in which action should be taken in order to realise ERA. It is likely however, that the extent to which there are deficiencies in these areas and hence the extent to which remedial action is required will vary according to the specific research sector in question.

113 COM(2007) 161 final (http://ec.europa.eu/research/era/pdf/era_gp_final_en.pdf)

114 'Challenging Europe's Research: rationales for the European Research Area (http://ec.europa.eu/research/era/pdf/eg7-era-rationales-final-report_en.pdf)

115 http://ec.europa.eu/research/era/2020_era_vision_en.html

116 http://eca.europa.eu/portal/pls/portal/docs/1/825583.PDF paragraphs 113-116 in particular

117 http://ec.europa.eu/research/reports/2009/pdf/fp6_evaluation_final_report_en.pdf#view=fit&pagemode=none

118 http://ec.europa.eu/research/environment/index_en.cfm?pg=impact

Taken together, these observations provide strong support for an ERA focussed sectoral stock taking study of the strengths, weaknesses, opportunities and threats for each of the thematic areas of scientific research supported by the FP. In simple terms, such studies may for example reveal that whilst one sector has well integrated programmes and priorities, its progress is delayed by a lack of new researchers entering the field and insufficient infrastructural capacity. Also, the development of ERA may vary among Member States and Associated Countries.

Consequently, the study will identify the extent to which ERA is being realised in the environmental research sector by identifying the barriers causing weaknesses in the sector or the characteristics contributing to success, taking into account the geographical dimension. Where possible, trends will be identified, allowing a regular assessment of progress / regress, including geographical disparities. Actions to improve the ERA dimension in the field of Environment will also be identified. This will permit future ERA policy to take account of this variable landscape and produce a rationale for future European level support for research in these areas.

The results of the study will primarily be used by the Commission in the further development of ERA research policy, but will also contribute to the evaluation evidence base which will be prepared for the overall assessment of the ERA in 2009-2010, the FP7 mid-term review, and the development of future Framework Programmes. Moreover, the results of the Study will be communicated to stakeholders.

THE EUROPEAN RESEARCH POLICY IN THE FIELD OF ENVIRONMENT: from FP6 to FP7

EU Framework Programmes (FP) provide impetus to coordinate European research efforts and contribute to identify solutions for societal problems. By their nature, they foster the integration of research activities and therefore play a strong role in the development of the European Research Area (ERA).

In the last decades environmental issues have become increasingly prominent in the international agenda. Addressing environmental issues is essential to achieving sustainable development, reconciling today's prosperity with future generations' well-being. This explains why EU Framework Programmes have given increasing attention since the 1980s to environmental issues. Specifically, environmental issues were reflected in the FP5 (1998-2002), became a thematic priority in FP6 (2002-2006) and one of the 10 themes in FP7 (2007-2013).

Some essential questions to which EU environmental research seeks answers are:

- What are the precise causes for climate change and how can we best tackle it?
- Is it possible to predict, prevent and prepare for natural disasters?
- How do environmental factors like pollution affect human health?
- How can we better understand and sustainably manage biodiversity and the marine environment?
- How can we make land use more sustainable?
- What technologies can improve environmental performance while contributing to growth and the creation of jobs?
- What type of international observation system of Environmental phenomena could we promote?
- What tools could be developed to identify the contributions of policies to Sustainable Development?

In all these issues, the Framework Programmes have sought to promote integration and strengthening of the European Research Area through the implementation of different

funding instruments. In FP6 they were: Networks of excellence (NOE)[119], Integrated Projects (IP)[120], Specific Targeted Research Projects (STREP)[121], Co-ordination actions (CA)[122] and Specific Support Actions (SSA)[123].

Moreover, the ERA-NET Scheme was implemented to foster the coordination and cooperation of national and regional programmes and as such, it aimed at the national and regional programme makers and managers. These are, in most countries, either working in the ministries or working in national funding agencies, which implement programmes on behalf of their governments. The ERA-NET Scheme was implemented via an Open Call for proposals, welcoming proposals for coordination actions in any field of science and technology i.e. using a bottom-up approach.

In FP7, the funding instruments are: Collaborative Projects (CP) (small or medium-scale focused research projects and large-scale integrating project); Network of Excellence (NoE), the 'Coordination and Support Action' funding scheme (CSA) (coordinating action or supporting action or ERA-Net – coordinating action) and 'Research for the benefit of specific groups'. Also the new ERA-NET Plus actions provide additional Community financial incentive to those national research programmes that pool financial resources to organise a joint call for proposals; ERA-NET Plus is planned to be applied only in a limited number of cases, which represent a particular European added value.

Covering the period 2002-2006, the thematic sub-priority "Global Change and Ecosystems" funded 280 projects with an overall budget of €852 millions. Within the FP7 'Cooperation' Programme, the theme dealing with environment (including climate change) has a budget of €1.9 billion.

STUDY OBJECTIVES, EVALUATION QUESTIONS, TASKS AND SCOPE

Study Objectives

The objective of the study is to assess the progress achieved and to identify actions to foster the development of the European Research Area in the field of environment, including through FP6 and FP7 research projects[124], and more specifically for the ten areas covered by Environmental research:

- Climate change
- Environment and health

[119] Multipartner projects aimed at strengthening excellence on a research topic by networking the critical mass of resources and expertise. This expertise is networked around a joint programme of activities aimed primarily at creating a progressive and lasting integration of the research activities of the network partners while, at the same time advancing knowledge on the topic.

[120] Multipartner projects to support objective-driven research, where the primary deliverable is knowledge for new products, processes, services etc. They should bring together a critical mass of resources to reach ambitious goals aimed either at increasing Europe's competitiveness or at addressing major societal needs.

[121] Multipartner research, demonstration or innovation projects whose purpose is to support research, technological development and demonstration or innovation activities of a more limited scope and ambition, particularly for smaller research actors and participants from candidate countries.

[122] Actions aiming to promote and support the networking and coordination of research and innovation activities. They will cover the definition, organisation and management of joint or common initiatives as well organisation of conferences, meetings, the performance of studies, exchanges of personnel, the exchange and dissemination of good practices, setting up common information systems and expert groups.

[123] Single or multipartner activities intended to complement the implementation of FP6 and may be used to help in preparations for future Community research policy activities. Within the priority themes, they will support, conferences, seminars, studies and analyses, working groups and expert groups, operational support and dissemination, information and communication activities, or a combination of these.

[124] In FP6 280 projects were funded. In FP7 148 projects have started or are under negotiation from the first two calls for proposals.

- Natural hazards
- Natural Resources Management
- Biodiversity
- Marine Environment
- Land and urban management
- Environmental technologies, including cultural heritage
- Earth observation
- Tools for Sustainable development

In the rest of this document, the terms 'environmental research' covers both the field of environment and the above ten areas.

Evaluation Questions

The Commission Communication "Towards a European Research Area" (COM(2000)6)[125], the Commission's Green Paper: "The European Research Area: New perspectives" (COM(2007) 161 final) [126], and Common 2020 vision for the European Research Area[127].identified the following features that the ERA should have:

- Well coordinated research programmes and priorities
- An adequate flow of competent researchers
- Excellent research institutions
- World-class research infrastructures
- Effective knowledge-sharing
- A wide opening of the European Research Area to the world.

The study will answer the following set of questions for the ERA in the field of environmental research, differentiating by geographical area according to their degree of research integration:

- What are the strengths and weaknesses in the field of environmental research which enable it or prevent it from exploiting the potential offered by ERA to address European competitiveness and research objectives?
- In which of the ERA features is action most needed in the field of environmental research?
- Are there any identifiable risks posed by the development of ERA in the field of environmental research?
- What actions can be taken to improve the ERA dimension in the field of environmental research?

[125] http://ec.europa.eu/research/area/com2000-6-en.pdf

[126] http://ec.europa.eu/research/era/consultation-era_en.html#greenpaper

[127] http://ec.europa.eu/research/era/2020_era_vision_en.html

Tasks

Task 1: Data gathering

The contractor will gather qualitative and quantitative data related to the different features of the European Research Area in the field of environmental research.

The tenderer will specify in the tender the different data sources that would be used for each ERA feature and detailed the method for data gathering that will be employed, including for the interviews.

ERA FEATURE: Well coordinated research programmes and priorities

The contractor will gather data related to research policies on national, regional[128] and European levels in the field of environmental research. Possible sources of information are: relevant research programmes, policy studies and official presentations.

Research policy portfolios

The contractor will focus the data gathering on the:

- Adequacy of EU and national policies to foster ERA, as identified in previous studies;
- Strategic priorities for research at EU and national level;
- Coordination between national and European funding schemes;
- Positive competition or negative fragmentation of the European research effort induced by national priorities
- Links with priorities of other national, intergovernmental, European and other international programmes;
- Percentage of national funding committed to a "common pot"/ joint programming for research at European level (breakdown by funding source/research area/ country)
- Effectiveness of these policy actions, as identified in previous studies.

Existing and planned public and private programmes

The contractor will gather data on the main existing and planned public and private programmes in environmental research at EU, national and regional level (see footnote 15), in particular on the:

- Adequacy of the different types of programmes and funding schemes to support ERA, as identified in previous studies;
- Levels of research investments;
- Coordination of programmes with other fields of research;
- National policies for the participation in national and Framework Programme funded projects, at sectoral and cross-sectoral levels;
- Review systems in place to select and assess research;

[128] In cases where RTD decisions, planning and funding are decided at regional level.

- Openness of national programmes to transnational participants.

ERA FEATURE: An adequate flow of competent researchers

Data on researcher demographics and policies addressing researcher flow in the field of environmental research will be gathered, notably on the:

- Adequacy of the researcher demographics to enhance ERA, as identified in previous studies;
- Demographics of the research population (levels and trends of employment of skilled persons and post-graduate students, including future perspectives, by gender);
- Training provisions and standards for skilled persons;
- Policies to promote job creation in research;
- Procedures for recruitment of new staff;
- Barriers to researcher mobility;
- Volume and patterns of transnational mobility across all sectors;
- Percentage of posts in universities / public research establishments held by non-nationals (breakdown by type of institutions and nationalities);
- Participation of Small and Medium Enterprises (SMEs) in research programmes at national, transnational and EU level;
- Sector-specific incentives to promote careers at both the EU and national level addressing the mobility challenges.

ERA FEATURE: Excellent research institutions

The contractor will gather data on research institutions in the field of environmental research, notably on the:

- Adequacy of the research institutions to foster ERA, as identified in previous studies;
- Leading actors and their global competitiveness (a detailed inventory is required);
- Level of interaction of the leading actors, as previously identified;
- Factors that characterise the leading institutions (autonomy, links to industry and society, part of virtual research communities through the use of information and communication technologies as well as innovative communication means);
- Level of administrative red tape in national and EU organisations;
- Level of administrative support for research project management.

ERA FEATURE: World-class research infrastructures

The contractor will gather data on research infrastructures in the field of environmental research, notably on the:

- Adequacy of the infrastructures to enhance ERA, as identified in previous studies;
- The capacity of infrastructure to undertake research and train researchers;
- Main on-going and planned infrastructures at both the EU and national levels;
- Accessibility of infrastructures across all relevant disciplines and industries;
- Standards for data production and sharing;

- Main transnational networks operating, and particularly the networks of excellence (detailed list required);
- Main areas, funding types and levels of international co-operation at EU, national and international levels, especially with the United States, Russia, China, India, and Brazil;
- Sector-specific incentives at the EU and national level to promote collaborative research within the sector;
- ERA-Net activities to foster research infrastructure
- Research infrastructures linked with European Technology Platform (ETPs;
- Other EU and national funding instruments for research infrastructures;
- Contribution (public and private) by country to the creation of infrastructures listed in the ESFRI[129] roadmap.

ERA FEATURE: Effective knowledge-sharing

The contractor will gather data related to knowledge sharing in the field of environmental research, notably the:

- Adequacy of knowledge-sharing and dissemination mechanisms between industry and academia to foster ERA, as identified in previous studies;
- Knowledge sharing and dissemination mechanisms between industry and academia;
- Use of information and communications technologies for information sharing;
- Knowledge transfer and its application to create innovative processes and products;
- Number of transnational co-publications by country, including the share of co-publications in the total number of publications of the country;
- Number of co-patents by country, including the share of co-patents in the total number of patents of the country;
- Management of intellectual property;
- Level of participation of Small and Medium Enterprises (SMEs) in the knowledge transfer process;
- National follow-up of the "Commission recommendation on the management of intellectual property in knowledge transfer activities and Code of Practice for universities and other public research organisations", C(2008)1329.

ERA FEATURE: A wide opening of the European Research Area to the world

The contractor will gather data on the international dimension of ERA in the field of environmental research, notably on the:

- Adequacy of international co-operation in research programmes to enhance ERA, as identified in previous studies;
- Role for experts from the rest of the world, notably from International Cooperation[130] (INCO) countries, in programme / policy design or implementation at national and EU level;

[129] European Strategy Forum on Research Infrastructures

[130] http://cordis.europa.eu/fp7/who_fr.html#countries

- Mobility schemes which favour researcher exchange between European and INCO[16] countries;
- Leading non European countries;
- Most frequent country partners in EU and national programmes;
- Member State co-operation agreements;
- Total national funding for research aimed at global environmental challenges.

Task 2: Analysis

The contractor will evaluate the state of ERA advancement in the field of environmental research on the basis of the analysis of the data gathered on the task 1. In particular, the contractor will:

- Identify progress achieved towards ERA;
- Identify gaps, weaknesses and opportunities for the fulfilment of each of the ERA features;
- Identify on which ERA features action is most needed and most urgent to continue progressing towards ERA;
- Identify risks for the development of ERA;
- Identify and assess the impacts of possible action to cover gaps, reduce the weaknesses and take advantage of opportunities to enhance ERA;

The tenderer shall propose in the tender the methodological approach for the analysis and evaluation of the progress towards ERA which is adapted to the field of environmental research,. The tender will present the methodological approach, including the development and estimation of indicators for the evaluation of the state of ERA advancement, as detailed above.

Task 3: Reporting

The contractor will present a set of reports as specified in point 6.1 of these TOR.

Task 4: Development of the quantitative data base

The contractor will deliver a database in access, excel (or similar software) including the disaggregated quantitative data gathered on the task 1. The database will also include any other data needed for estimating the indicators developed on the task 2. The database will include the queries for the estimations of indicators.

The tenderer will include in the tender the proposed structure of the database.

Scope of the Evaluation

The evaluation should cover the EU as well as Associated Countries[131] having participated in both FP6 and FP7.

DATA

Data Sources

The tenderer must specify in the tender the data sources (existing relevant studies as well as EU and national datasets) that are relevant for the study and describe how they

[131] Croatia, Iceland, Norway, Switzerland, Turkey.

should be used. In cases where the tenderer foresees problems obtaining the necessary data, for example, because they might not be directly available, incomplete, contained in private databases or for any other reason, the tenderer must mention this and explain how these problems could be overcome.

Available Information

Information on research activities, the European Research Area, the Framework Programmes and the specific research programmes is available on the CORDIS web site at the following address: http://www.cordis.lu/en/home.html, and on the EUROPA web site at: http://europa.eu.int/pol/rd/index_en.htm, http://europa.eu.int/comm/research/index_en.html

The contractor will be authorised to use the data related to FP7[132] projects from the CORDA database of DG RTD.

Special account should be taken of the objectives set out in the Sixth and Seventh Framework Programme decision; the results of the Enwise report http://ec.europa.eu/research/science-society/women/enwise/enwise_report_en.html; the Five Year Assessment and the CIRCA web-ring database at http://forum.europa.eu.int/Public/irc/rtd/fiveyearasskb/library?l=/iii-knowledge_base&vm=detailed&sb=Title; the Marimon report and corresponding responses to the European Parliament and Council, the policy considerations presented in the recent ERA Green paper and its annexes at http://ec.europa.eu/research/era/index_en.html and the common 2020 vision for the European Research Area http://ec.europa.eu/research/era/2020_era_vision_en.html .

Other relevant sources of information are the ERA-WATCH web pages (http://cordis.europa.eu/erawatch/) and relevant environment ERA-NET websites[133].

Licences

The tenderer has to prove that the correct licenses to use the databases that will be used to do the work are at the tenderer's disposal. The tenderer has equally to ensure that all intellectual property rights associated with existing databases will not conflict with any usage of the indicators, derived under the contract, by the Commission services.

The tenderers are reminded that it is their responsibility to ensure that they hold the correct licences (direct licence or through a service provider such as a specific host or university) to perform and disseminate the work. The data obtained in the context of the envisaged Specific Contract will be in detailed form for Commission internal use and in aggregated form for external publications.

DURATION OF THE STUDY

The duration of the study shall be 12 months from the date of signature of the specific contract by the last of the contracting parties. In case the Framework Contract BUDG 06/PO/01/Lot003 is not renewed, the specific contract is automatically terminated without further justification six months after the expiration date of the Framework Contract without the contractor being entitled to any compensation for damage incurred

[132] CORDA provides access to a collection of existing management reports, data and IT reporting tools on FP7 implementation. In the field of environmental research, 178 contracts have been signed or are under negotiation from the first two calls for proposals.

[133] www.ampera-net.info, www.eurobiodiversa.org, www.bonusportal.org, www.circle-era.net, www.crue-eranet.net, www.ecord.org, www.europolar.org, www.euwi-era.net, www.iwrm-net.org, www.marifish.net, www.marinera.net, www.netbiome.org, www.skep-era.net, www.snowman-era.net, www.SUSPRISE.net, www.urban-net.org, www.era-envhealth.eu, www.netheritage.eu

as a consequence of such a termination. In that case, the Contractor shall submit a report on the work carried out accompanied by the corresponding invoice.

The Contractor shall report directly to the Unit of Directorate I of DG RTD in the Commission responsible for the study. Reporting shall be in English, and any information collected in this study shall remain the property of the Commission for one year from the end of the contract. The Contractor must agree to respect the confidentiality of any party to the contract (affecting, for example, intellectual property rights) with respect to the data collected, or have accessed to.

Expected timeline: September 2009 – **August** 2010

DELIVERABLES AND MEETINGS

Deliverables

Deliverable 1 (D1)	**At the latest at the end of month 1 after signature of the contract by the last of the contracting parties**
The contractor shall present an Inception report (no more than 15 pages) outlining a detailed description of the evaluation strategy, and practical steps to be followed in the implementation of the methodology as proposed in the tender. The list of stakeholders, established in collaboration with the Commission ad hoc Group (see point 6.2 for the description), shall be added as annex to the inception report. The Commission will approve the Inception report or make comments within 15 days. In the last case, the contractor shall have 15 days to submit a revised version.	

Deliverable 2 (D2)	**At the latest at the end of month 6 after signature of the contract by the last of the contracting parties**
The contractor shall present a First intermediate report based on the results obtained so far. This report should present the data collected as specified in task 1 and a preliminary analysis as specified in task 2. The intermediate report shall be not more than 20 pages of written text, excluding the annexes. The annexes should include the detailed analysis for each feature. The Commission will approve the First intermediate report or make comments within 20 days. In the last case, the contractor shall have 15 days to submit a revised version.	

Deliverable 3 (D3)	**At the latest at the end of month 8 after signature of the contract by the last of the contracting parties**
The contractor shall present a Second intermediate report providing a full analysis as specified in task 2 on the basis of the data gathered in task 1. The report shall also make suggestions for disseminating the results of the study that the Commission might take into consideration. The Commission will approve the Second intermediate report or make comments within 20 days.	

Deliverable 4 (D4)	**At the latest at the end of month 10 after signature of the contract by the last of the contracting parties**

The Draft final report shall be presented to the Commission taking into account the Commissions remarks to the Second intermediate report.

The structure of the Draft Final report (of around 50 pages + Annexes) should be worked out according to the following lines:

1. Introduction – overview of European research and ERA development in field of environmental research and the objectives of the study;
2. Contribution of environmental research to the ERA development;
3. Progress achieved, gaps, weaknesses and opportunities for each of the ERA features;
4. Actions most needed and most urgent to continue progressing towards ERA;
5. Risks for the development of ERA in the field of environmental research.
6. Possible action to enhance ERA and its impact;
7. Conclusions and recommendations

Annexes

I. Definition of tasks, work organisation and methodology;

II. Detailed presentation of the data and analysis by ERA Feature

- Coordination of research programmes and priorities;
- Flow of competent researchers;
- Research institutions;
- Research infrastructures;
- Knowledge-sharing;
- Opening of the European Research Area to the world.

III. Conclusions of the Stakeholders' seminar.

The Commission will approve or make comments to the Draft final report within 20 days.

Deliverable 5 (D5)	**At the latest at the end of month 10 after signature of the contract by the last of the contracting parties**
An Executive summary (maximum 3 pages) summarising the purpose, methods used, key findings and possible recommendations of the study. The Commission will approve the Executive summary or make comments within 20 days. In the last case, the contractor shall have 15 days to submit a revised version.	

Deliverable 6 (D6)	**At the latest at the end of month 10 after signature of the contract by the last of the contracting parties** (submitted as annex to Deliverable 6)
All quantitative data collected under this contract will be delivered in the form of a Database, including the accompanying queries to estimate the indicators, as specified in task 4. The data will be the property of the Commission. The Commission will approve the Database or make comments within 20 days. In the	

last case, the contractor shall have 15 days to submit a revised version.

Deliverable 7 (D7)	**At the latest at the end of month 11 after signature of the contract by the last of the contracting parties**
The contractor will prepare a Presentation of the results of the study, (in PowerPoint or equivalent), with explanatory notes and will present the results of the evaluation study to the Commission in Brussels. The Commission will approve the Presentation of the results of the study or make comments within 20 days. In the last case, the contractor shall have 15 days to submit a revised version.	

Deliverable 8 (D8)	**At the latest at the end of month 12 after signature of the contract by the last of the contracting parties**
Taking into account the Commission's comments on the Draft Final Report, the Final report shall be delivered to the Commission in 5 bound copies in the form proposed in the tender application, as well as in electronic format (word and pdf – or equivalent) suitable for web dissemination. The Commission will approve the Final report or make comments within 20 days. In the last case, the contractor shall have 15 days to submit a revised version.	

All documents under the Specific Contract are to be submitted by the contractor in English unless otherwise specified.

All reports, documents and supporting information must be made available in electronic format such as Microsoft Word XP (2003), Powerpoint XP (2003), Access XP (2003) and Excel XP (2003) (or equivalent) as agreed with the Commission services. The contractor must also provide five paper copies of the final report and its annexes in the agreed format.

Meetings

A "Commission ad hoc group" (CahG) will follow the implementation of the evaluation of ERA in the field of environmental research. It will be composed of Commission staff, up to five national contact persons and possibly of other external experts. It will monitor the preparation, progress and results of the study and meet with the contractor according to the indicative schedule presented below.

In drawing up the tender, the tenderer needs to bear in mind that the contractor is expected to take part in **4 meetings** which will take place on Commission premises in Brussels and at the expenses of the contractor:

M1: a Kick-off meeting at the beginning of the evaluation study;

M2: an Intermediate meeting;

M3: a Seminar with Stakeholders to present and discuss the results of the evaluation study

M4: a final meeting with the Commission.

M1: Two weeks after the signature of the contract by the last contracting party, a kick-off meeting of the contractor with the CahG will be held on Commission premises in Brussels. The Contractor will prepare the agenda and supporting documents and send it to the Commission at least 5 working days before the meeting. The contractor will deliver to the Commission the minutes not later than 5 working days after the meeting. This meeting will be organised to fine-tune the evaluation approach and methodology to be used during the contract and to prepare the work to be carried out.

M2: During **month 7**, the contractor shall meet the CahG in Brussels for the intermediate meeting to present the First Intermediate Report and the steps planned for the continuation of the work. The meeting will give an opportunity to the CahG to fine tune the approach with the contractor, assess the effectiveness of the methods applied and settle for the details of the remaining work. The agenda and supporting documents shall be presented by the contractor to the CahG not later than 10 working days before the meeting. The minutes shall be written by the contractor and presented to the CahG not later than 5 working days after the meeting.

M3: During **month 9** the Commission will organise a seminar with Stakeholder in Brussels to discuss the preliminary results of the study as set out in the Second Intermediate Report. The contractor will prepare and present to the Commission for approval at least 15 working days before the seminar the agenda, the supporting documents, the list of suggested participants and a list of at least two key external stakeholders who have taken part in the study and could present selected aspects of the situation in her/his Country and comment the outcomes of the study. the contractor will produce 15 working days after the Seminar a document with the conclusions of the Stakeholder seminar. This document will be one of the annexes to the Draft final report.

M4: During **month 11**, the final meeting (maximum 1,5 days) with the CahG, other Commission services and other external stakeholders will he held in Brussels to present the Draft final report. The agenda and supporting documents will be submitted by the Contractor to the Commission at least 10 working days before the meeting. The contractor will deliver the minutes at the latest after 5 working days of the meeting.

Timelines for Deliverables, Meetings and Payments

Deliverables (D), Meetings (M), and Payments (P)	**Deadline (Month)**
M1: Kick-off meeting with the Commission in Brussels D1: Inception report	**1**
P1: First payment	**2**
D2: First intermediate report	**6**
M2: Intermediate meeting	**7**
P2: Interim payment D3: Second intermediate report	**8**
M3: Seminar with stakeholders	**9**
D4: Draft final report D5: Executive Summary of the final report D6: Database	**10**
D7: Presentation of the results of the study M4: Final meeting	**11**
D6: Final report P3: Payment of balance	**12**

QUALITY REQUIREMENTS

There are two types of Quality Assurance that are required under the envisaged Specific Contract:

Requirements of the Framework Contract

The output of the Specific Contract will be subject to quality requirements as specified under point 6.2 of the Terms of Reference for the Framework Contract. The deliverables produced by the Contractor will therefore be assessed ***ex-post*** in accordance with the Quality Assessment Framework provided in Annex III. Notwithstanding the obligation to produce activity reports and to attend monitoring meetings as required by points 6.3 and 6.4 of the Terms of Reference for the Framework Contract respectively, the successful tenderer will be expected to integrate information on quality control measures into the reports and deliverables of the Specific Contract.

The quality plan

In addition, the Contractor is expected to propose appropriate and high-quality methodologies and to respect the quality plan included in their tender as required by point 6.1 of the Terms of Reference for the Framework Contract. To this end, the tender should contain a detailed ***ex-ante*** quality plan, which will be evaluated against the award criteria and which must be adhered to if the tender is successful.

The Commission services will nominate a Commission ad hoc Group (CahG) as described in point 6.2 of the TOR, to advise and monitor the execution and follow-up of the Specific Contract.

PRICE AND PAYMENTS

Price

The price must be a fixed amount, which is not subject to revision and includes all expenses, including travel and subsistence expenses. The price will be presented as a lump-sum on the basis of the expert prices and fixed travel and subsistence costs established according to the price schedule presented in the tender for the Framework Contract BUDG 06/PO/01/Lot 3. No separate reimbursable expenses will be accepted. The estimated travel and subsistence expenses considered necessary by the tenderer in order to carry out the study and any translation costs must be indicated separately.

Prices should be quoted free of all duties, taxes and other charges, including VAT, as the European Community is exempt from such charges under Articles 3 and 4 of the Protocol on the privileges and immunities of the European Communities of 8 April 1965 (OJ No 152 of 13 July 1967); the amount of VAT should be shown separately.

The total price for the services (including travel and subsistence expenses) cannot exceed 250,000 Euro.

Payments

There will be three payments for this specific contract.

First payment (corresponding to 20% of the specific contract):

After reception of the Inception Report (D1), the Commission shall have 15 days to approve or reject it while requesting changes. In the second case, the contractor shall have 15 days in which to submit a revised Inception Report (D1). The request for the

first payment shall be admissible after the approval of the Inception report. The payment will be made within 30 days of the reception of the invoice.

Interim Payment (corresponding to 40% of the specific contract):

After reception of the First intermediate report (D2), the Commission shall have 20 days to approve or reject it while requesting changes. In the second case, the contractor shall have 15 days in which to submit a revised version of the First intermediate report. The request for the interim payment shall be admissible after the approval of the First intermediate report (D2). The payment will be made within 30 days of the reception of the invoice.

Payment of the balance (corresponding to 40% of the specific contract):

After approval by the Commission of D3: Second Intermediate Report, D4: Draft Final Report, D5 Executive Summary of the final report, and D6: Database, D7: Presentation of the results of the study and D8: Final report, the request for the payment of the balance shall be admissible. The payment of the balance will be made within 30 days of the reception of the invoice, in accordance with the Art. I.5 of the Framework Contract.

CONTRACTUAL CONDITIONS

In preparation of the tender, the tenderer should bear in mind the provisions of the standard Specific Contract attached to these specifications (Annex II) which will specify the rights and obligations of the contractor particularly those on price (Article III.3) and payments (Article III.4). He should also bear in mind the provisions of the main framework contract relating to conflict of interests (Article II.3), confidentiality (Article II.9), penalties and liquidated damages (article II.16), and checks and audits (Article II.17).

The contractor shall be bound by the provisions of Directive 95/46/EC of the European Parliament and of the Council of 24/10/1995 on the protection of individuals with regard to the processing of personal data and on the free movement of such data[134].

The contractor will have sole responsibility for complying with all legal obligations incumbent on him, notably those arising from employment law, tax law and social legislation.

The contractor may neither represent the Commission nor behave in any way that would give such an impression. The contractor must inform third parties that he does not belong to the European public service, but is exercising the tasks on behalf of the European Community.

The contractor will be solely responsible for the staff carrying out the work, who may not be placed in a position of dependency in relation to the Commission.

CONTENT OF THE TENDER

Within 5 working days of receiving the Request for Services, the tenderer shall express in writing, by post or e-mail, his availability to carry out the services required. Within the deadline set in the Request for Services the tenderer will provide the Commission services a tender for the Specific Contract in writing, including an outline of the methodologies proposed, the tasks required, a work programme and a lump-sum price for the order.

Content of the tender

The tender must include

a) A technical tender providing:

- a clear and detailed description of the proposed work to be undertaken which develops the evaluation questions and links them to the objectives and tasks, including a timetable;
- a detailed description of the data gathering methods, the data sources to be employed and the organisation of the data in a database;
- a detailed description of the analytical and evaluation methodology and how it will be implemented
- a demonstration that the team proposed by the tenderer has:
    1. at least three years of competence in research programme evaluation;
    2. knowledge of environmental research policies and programmes in the EU and in at least 5 of the countries studied;
    3. knowledge of research systems, institutions and infrastructure at national and international level.

[134] Official Journal L 281, 23/11/1995 p.0031-0050

- a clear identification of the resources that the contractor can dispose of to undertake the tasks:
    1. The proposed organisational and logistical aspects of the study, including description of the management structure, participating consortium members (where applicable), details of how regular internal communication will be organised, and any advisory panels;
    2. The proposed allocation of consortium members and individual staff to tasks and the allocation of other resources to tasks;
    3. A complete list of the individuals in the working teams, including all CVs, recent relevant publications and professional experience for each individual and how this will be utilised for each part of the evaluation study. This section should also be summarised in the form of a table of no more than one page;

b) A quality plan which is consistent with the Quality Plan provided in the tender according to point 6.1 of the Terms of Reference for the Framework Contract;

c) A financial offer.

Other provisions

The tender must be signed and dated by the tenderer or his/her authorised representative.

Variants are not permitted.

Expenses incurred in respect of the preparation and presentation of tenders cannot be refunded.

Fulfilment of the conditions of the call for tenders imposes no obligation on the Commission to award the contract.

Initiation of a tendering procedure imposes no obligation on the Commission to award the contract.

The Commission is not liable for any compensation to tenderers whose tenders have not been accepted. Nor is it liable if it decides not to award the contract.

All the documents submitted by tenderers become the property of the Commission. These documents will be considered confidential.

AWARD OF THE SPECIFIC CONTRACT

The specific contract will be awarded to the most economically advantageous tender evaluated on the basis of the price and of the following award criteria (c.f. Annex II of the Terms of Reference of the Framework Contract):

- **Understanding of the services and general approach to the work to be performed** (max 25 points).
- **Proposed methodology and tools**, taking into account the *ex-ante* quality plan, in particular:
    - the credibility and rigour of the evaluation design (max 25 points) and
    - the realism of data collection and analysis techniques (max 25 points).
- **Approach proposed for the management of the work**, in particular the clarity of objectives and milestones and the soundness of resource allocation (max 25 points).

The figures in brackets indicate the maximum score that can be attributed to each award criterion. Tenders which do not obtain at least 50 % of the maximum score for each quality criterion and at least 60 % of the overall score for all criteria, will not be admitted to the next stage of the evaluation procedure.

The tender will be assessed in terms of the total price for the tender on the basis of the specific unit prices set in the Framework Contract, broken down by categories of experts and travel and mission expenses.

In order to determine the tender offering the best quality-price ratio to which the lot will be awarded, the total quality score will be divided by the total price of the tender, these two aspects having the same weight.

If it decides to proceed with the award of a Specific Contract in response to a contractor's tender, the Commission will send the contractor a Specific Contract. The contractor has 10 days in which to sign and return the Specific Contract to the Commission. The tender, the main Framework Contract and its Annexes will be annexed to the Specific Contract and will be contractually binding.

CLAIMS AGAINST THE COMMISSION

The claims against the Commission are non-transferable.

APPLICABLE LAW AND JURISDICTION

The Specific Contract arising from this Request for Services and its amendments shall be governed by the national substantive law of Belgium.

Any dispute between the European Commission and the contractor(s) or any claim by one party against another under any contract arising from the interpretation or application of the Specific Contract which cannot be settled amicably by the contracting parties shall be brought before the Brussels' Courts.

ANNEXES

I. COPY OF SIGNED FRAMEWORK CONTRACT
   - A. FRAMEWORK CONTRACT TENDER SPECIFICATIONS
   - B. CONTRACTOR'S TENDER FOR THE FRAMEWORK CONTRACT

II. DRAFT SPECIFIC CONTRACT

III. QUALITY ASSESSMENT FRAMEWORK

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[i] European Commission (2007), The European Research Area: New Perspectives - Green Paper: 04.04.2007, Luxembourg (+ results public consultation).

[ii] European Council Conclusions 29 and 30 May 2008.

[iii] P. Laredo (2008), "Discussing the role of ERA in the Lisbon process, the divers understandings of the ERA and the role of the framework programme in fostering Europeanisation", Background paper for the FP6 expert panel.

[iv] European Commission (2010), "Europe 2020 Flagship Initiative Innovation Union", COM(2010) 546 final.

[v] The six dimensions are: 1. Well-coordinated research programmes and priorities; 2. An adequate flow of competent researchers; 3. Excellent research institutions; 4. World-class research infrastructure; 5. Effective knowledge sharing; 6. A wide opening of the European Research Area to the world.

[vi] Among other: Framework Programme participation data, publication and patent data, Eurostat, OECD, National, Erawatch and Trendchart, ESFRI, NETWATCH.

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Taking stock of the progress of the European Research Area (ERA) in the field of the environment, this study recommends measures to further promote and develop a Europe-wide open space for environmental knowledge. Compared to the state of affairs in 2000 when the ERA was launched, progress has been made in achieving the ERA objectives in environmental research and innovation. Solid trans-border networking and coordination of research agendas is underway even though governance aspects still need to be tackled. More structured public-private collaboration is needed to further exploit the potential of eco-innovation.

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