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EC Environmental Research and EC Environmental Policy

A study in the utilization of knowledge for regulatory purposes

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INTRODUCTION

Environmental degradation due to various kinds of human activities and products became an EC policy issue in the early seventies, starting from the Summit of the Heads of State or Government held in Paris in 1972.
Since then four Environmental Action Programmes and an impressive number of environmental Directives have been approved.

Regulatory activities usually require the use of specialized expertise, and this seems to be particularly the case in the environmental field where many problems have to be dealt with starting from their scientific analysis. Moreover, concerns for man-made environmental damages and search for solutions imply an important question, that is whether it is possible to benefit from human knowledge in order to repair or prevent damages partially due to harmful applications and management of knowledge itself. The relationships between environmental research and environmental policy deserve then some investigation.

After a modest start -in 1971- of research coordination in the environmental field, in 1973 a first Research Programme on Environment Protection was adopted, followed by other programmes and contracts regarding in-house, cost-shared and coordinated research in the environmental area.
A comparate analysis of the Research and the Action Programmes in the environmental field and the examination of some environmental Directives (particularly regarding their scientific basis) can shed some light on problems like the interplay between knowledge and discretion, the management of scientific uncertainties in the

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policy process, the bargainings over policy priorities and instruments but also over controversial scientific issues, the difficulties connected with the different timing of politics and research, the influence of the broader political, economic and scientific context.

The development of institutional links between environmental policy and research at the Community level is also addressed, focusing on coordination, evaluation and control problems. Knowledge may help environmental policy only if research and information are coordinated, if the quality and utilization of research results are evaluated, and technological outputs assessed and "controlled" by society and its representative institutions.

Finally, it is important to stress that environmental degradation does not stop at political borders and that EC environmental policy and research have then to be considered in the light of the global international context.
Political and scientific cooperation at the international level is increasingly important in order to face the environmental challenge.
And the EC should play a more and more active role in the common undertaking.

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1. THE BEGINNINGS OF EC ENVIRONMENTAL POLICY AND RESEARCH.

After years of quick economic growth following the Second World War, in many industrialized countries -beginning from the early fifties- the environmental damages due to uncontrolled exploitation of natural resources and to neglect of the environmental impact of industrial and agricultural activities, energy production, and so on became evident.

In 1953 a cloud of smog killed hundreds of old people in London, in the sixthies discharges of mercury from a chemical plant provoked sea pollution and the death of forty eight inhabitants of Minamata in Japan, in 1967 the accident of Torrey Canyon caused a serious and widespread sea and coastal pollution. And the list could be extended.

Attempts to develop comprehensive environmental policies started only in the seventies. In 1970 the Environmental Protection Agency, aimed at regulating virtually all sources of pollution, was established in the USA. In the same year an Environmental Committe was also established within the OECD.

In June 1972 was held in Stockholm the UN Conference on the Human Environment: for the first time environmental degradation, its causes and some possible remedies were discussed in such an authoritative international forum. Few days before the starting of the UN Conference, the OECD Council approved a Recommendation on "Guiding Principles Concerning International Economic Aspects of Environmental Policies" where the economic importance of setting common standards and applying the Polluter-Pays-Principle (PPP) were emphasized.

In October of the same year the Heads of State or Government of the EEC emphasized the importance of having a Community

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environment policy and invited the Commission to establish a programme in that field. As a consequence, in 1973 the first EC Environment Action Programme was adopted.
This was not the first environmental action decided at the EC level: in 1967 the first environmental Directive was approved (Directive 67/584/EEC on classification, packaging and labelling of dangerous substances), in 1970 the European Parliament urged measures to control the pollution of the Rhine, and in 1971 the Commission prepared its first Communication in the field of Environment Protection (SEC (71) 2616 final). However, the first Environmental Action Programme represents the official start of the building of a comprehensive EC environmental policy.

Given the transboundary nature of environmental problems and the attention paid to them by UN and OECD, one can ask why the EC countries (that are also members of these international organizations) decided to start a specifically EC environmental Policy.
Geographical, technical, economic and political reasons can be mentioned.
The geographical reason could be that even if many environmental problems are global, some of them have a more limited scale and then a joint "regional" effort would seem appropriate given the closeness of EC Countries. But a "regional" environmental problem like the pollution of the Baltic concerns not only EC but also other european countries, and another regional issue like the bad state of the Mediterranean Sea is not only a European (EC and non-EC) problem but regards also Middle-East and African Countries. Therefore geographical closeness cannot be considered a crucial reason to start a specifically EC environmental policy.
A technical reason could be the need to coordinate at the international level the available technology (for example, monitoring stations and instruments) and the scientific personnel

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in order to better face transboundary pollution and to avoid duplication of efforts and expenses.
But transboundary pollution and global problems like ozone layer depletion demonstrate that such cooperation is necessary at a broader international level. Moreover scientific and technical cooperation in the environmental field can be regarded as a tool, more that a reason, for starting and implementing environmental policy.
A certainly relevant and explicit reason for developing a specifically EC environmental policy is an economic one, that is the attempt to avoid distortion of competition within the EC and between EC and non-EC (especially US and Japan) countries. In fact the setting of common standards and the homogeneous implementation of the Polluter Pays Principle at the Community level are important instruments to facilitate the trade of products and technologies within the Community and to face the concurrence of non-EC products.
Two other important reasons to be mentioned are political ones: the need to cope with public opinion environmental concerns in order not to lose legitimacy (and this was important especially for representatives of those member States where environmental issues were more debated), and the intention of the EC institutions (particularly the EC Commission) to broaden their influence and power over member States through the creation of a new EC policy domain. Reference to public opinion concern is explicit in many official documents, and even if documents do not "tell the whole truth" this can be interpreted as a sign of the need for politicians to take citizens (electors) into some consideration. Concerning the second aspect, at first sight it does not seem that the Commission as an whole attributed -till recent times- much importance to the development of environmental policy: for instance, the annual budget for environment represented, till 1986, less than 0,001 of the total budget of

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the Commission, and the Directorate-General for Environment, Consumer Protection and Nuclear Safety (now, Environment, Nuclear Safety and Civil Protection) - DG XI - has been understaffed and underbudget in comparison with other departments (S. Johnson-G. Corcelle, 1987: p.21). Obviously budget allocation is not the only indicator to be taken into consideration, and a deeper analysis (which is beyond the scope of this study) would be required to test the mentioned hypothesis regarding the intention of the EC Commission to broaden its influence.

Having examined some possible reasons for initiating a specifically EC environmental policy, it shall be pointed out that environmental problems involve the need to analyze not only physical, chemical, biological processes, but also social processes regarding the interactions between humans and nature (mainly the environmental impacts of human activities and, on the other hand, the natural constraints to economic development, population growth, etc.). Therefore it is important to see if scientific research (including both natural and social sciences) has been -and is currently- used as a basis for EC environmental regulation.

The first EC research activity relating to the environment can be considered the one regarding the effects of ionizing radiation on the environment which was started in 1961 within the framework of the Euratom Treaty. But it was a quite isolated episode.

Coodination of environmental research was started -not exclusively at the EC level- in 1971 with three COST (Coordination of Science and Technology) agreements regarding physico-chemical behaviour of atmospheric pollutants, analysis of organic micropollutants in water and treatment of sewage sludge.

In-house, or direct, research by the Joint Research Centre (particularly the Ispra establishment) and cost-shared research based on contracts between the EC Commission -DG XII-

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(Directorate-General for Science, Research and Development) and scientific institutions of member States began in 1973, that is the same year of the adoption of the first Environmental Action Programme.

The transition in 1973 from mere coordination of research to financing of direct and cost-shared research, together with the enlargement of the research areas, indicates an increased commitment to develop EC environmental research more or less parallel to the commitment to establish EC environmental regulation.

But why start a specifically EC environmental research instead of relying on the research carried on within member and non-member "leading" States or within international bodies like the United Nations ?

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2. EC ENVIRONMENTAL RESEARCH IN CONTEXT: SCIENCE-RELEVANT POLICY AND POLICY-RELEVANT SCIENCE.

The starting and developing of EC environmental research has to be analyzed in the context of EC research policy and in the context of EC environmental policy, without neglecting the broader international context.
These two aspects are distinct even if they are not separable. Research policy provides some orientations (mainly regarding budget allocation and the choice of priority areas) which condition the shaping of any kind of research, including environmental research. In turn, research policy is influenced by other policies, and among them (but usually in a not very strong position) also by environmental policy, which need research as a basis for regulatory activities or in order to better achieve goals like technological and economic competitiveness. In the EC context, the research programmes proposed by DG XII are submitted for suggestions to the other Directorates-General of the Commission and a common agreement is needed to approve the final programme.
Science-relevant policy (i.e. not only direct science policy but also the aspects of other policies influencing the shaping of research) and policy-relevant science (i.e. science which is required as a basis/input for policy) are interdependent.

2.1. Science-relevant policy.

Till the early seventies the Community's Research and Development (R & D) activities covered almost exclusively the nuclear sector. In fact the EEC Treaty of 1957 containts no requirements regarding

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Community's R & D, aside from a mere reference to the coordination of agricultural research. The previous (1951) European Coal and Steel Community commissioned research on coal and steel production and on safety aspects, but it did not give rise to a specifically EC research policy. Research on nuclear fission and fusion, reactor safety, radiological protection and other related topics was instead provided for by the Euratom (European Atomic Community) Treaty, also signed in 1957. And in order to perform such research at the European level, the four establishments (Geel, Karlrsruhe, Ispra and Petten) constituting the Joint Nuclear Research Centre (JNRC) were also organized on the basis of the Euratom Treaty provisions.

In 1963, during the first Ministerial Meeting on Science organized by the OECD, the need to coordinate national projects and international scientific activities was expressed (J.J. Salomon, 1968: p.67), and in 1965 government experts from the EC member States - at that time six - came together to identify growth sectors in European science and technology: among these sectors was included environment protection (R. Herman, 1986: p. 150).

In 1971 (as was previously mentioned) coordination of research in the environmental and in other fields was started by nineteen Countries - among them the EC ones - with various COST agreements, and in 1973 the first EC research programme in the environmental field was approved. The first Framework programme on Community's research, development and demonstration activities was adopted only ten years later.

Some considerations can be made on the basis of this brief chronology, and some reasons to start a Community R & D -including environmental research- policy can be suggested.

a. Nuclear research has been the leading sector of EC research activities till the early seventies and the JNRC - i.e. the only specifically EC scientific and technical resource - was exclusively a nuclear research centre. The crisis of the European

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Atomic Community, mainly due to the prevailing of national nuclear policies and technologies (D. Holdsworth - G. Lake, 1988), left some room for the starting of other research areas at the Community level.

Therefore, when environmental issues attracted the attention of scientists and politicians at the international and at the EC level, and when an EC environmental policy (in need of environmental research) was started, some human and technical resources were already available - and looking for utilization - in the Community. Obviously these resources -to be useful for new and different kinds of research- needed some reconversion. The JNRC was partially reorganized and called JRC to make explicit - starting from the name- that nuclear research was no more the only one conducted within the Centre. In 1973 "in-house" environmental research was started in Ispra (the largest establishment of the JRC), and the attempt was made to utilize the already available staff (mainly nuclear physicists) and technology for different purposes. But while it has been relatively easy to modify the research activities within the nuclear field (for instance, from the study of new kinds of reactors to reactor safety), or to transfer the same kind of knowledge from one area to a near one (for example, engineering knowledge concerning safety devices can be quite easily transferred from the area of nuclear reactors to other types of installations), it is more difficult to start new research with "old" tools. Which means that the utilization of available resources represents at the same time a positive input and a constraint to the starting of new activities.

b. Economic considerations played an important role in the perceived need of improving international coordination and cooperation at the scientific level, and to initiate a Community R & D policy covering "strategic" (meaning, in this context, economically relevant) areas. For some countries, the sharing of effort may represent a way of supplementing national research

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reducing -instead of increasing - their costs, while for other countries (with smaller resources) scientific cooperation may represent the only possibility of engaging in large-scale activities (J.J. Salomon, 1968). This kind of reciprocal benefit can play a role within Europe, where there are still major national differences in levels of investement in R & D (EC Commission, First Report on the state of science and technology in Europe, COM (88) 647 final), and where joint efforts and distribution of EC funds can be regarded as a good opportunity for all member countries. These considerations are relevant also with regard to the relationships between the EC countries and their main scientific and economic competitors, particularly the US, because no one of the European countries could develop alone the sort of large-scale research which is conducted in the US (space research being a case in point).

Also environmental research involves important economic aspects: its technological ouputs (for instance, clean technologies) increasingly represent a very good business and directly influence the competitiveness of EC industry. Moreover, not to depend on external (i.e. coming from outside the EEC) research relevant for environmental regulation can allow substantial savings.

c. A political reason to develop a specifically EC research policy, including environmental research, could be the attempt to improve European political integration through scientific cooperation and international laboratories (A. Teich, 1974). In this respect it can be noted that in the eighties the EC political and economic commitment in the field of scientific and technological development is remarkably increased: two (1984-1987 and 1987-1991) Framework Programmes of Community activities in the field of research and technology development were adopted, a special provision on research and development was included in the Single European Act of 1987 that amended the EEC Treaty of 1957, and the number of cost-shared contracts and COST agreements

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is growing. However in 1988 the vast bulk of research still continued to be financed and carried out at the national level, the total cost of projects supported by Community's programmes being equivalent to about 4% only of total estimated EC public and private spending on civil research (EC Commission, First Report on the State of Science and Technology in Europe: p. 9).
Therefore, even if scientific coordination and collaboration in the Community is improving, european scientists are still working very much on a national basis. Furthermore they find often more easy -or more prestigious- to collaborate with US scientists than with other europeans because of lack of information, already established links, and other financial, academic and organizational reasons.
It seems then that the practical (financial and organizational) basis for improving political integration through scientific cooperation is still quite weak.

2.2. Policy-relevant science.

Environmental regulation requires various kinds of scientific inputs in order to define standards, to set limit values, to establish if a product is toxic or not, to assess risks, to find out which kind of curative or preventive measures are feasible. Epidemiological and toxicological studies, laboratory and field experiments to test causes and paths of pollution, and other research activities aimed at solving the above mentioned practical, regulatory problems, are a necessary basis for environmental policy. The problem is that such a scientific basis is often uncertain and controversial.
Scientific uncertainties and controversies between experts may arise because of the **nature of the question** or/and because of the **social and organizational context** in which scientists operate.
The term "trans-scientific" was introduced by Alvin Weinberg

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(1972) to define non purely scientific questions, that is questions that can be stated in the language of science (in the strict sense of "hard" sciences) but are unanswerable -in principle or in practice- in purely scientific terms. One example of trans-scientific questions mentioned by Weinberg is the one regarding the effects of low doses of radiation on human health. This question (which is at the core of the activities of one of the most influential international scientific organizations, that is the International Commission for Radiological Protection) is unanswerable in purely scientific terms because of the huge number of animal testing that it would require to produce sound results and because of the conceptual difficulties regarding the extrapolation of results from animal laboratory tests to human health in normal conditions.

In dealing with trans-scientific issues political, economic and social judgements enter then the arena and condition the interpretation of results and the decisions to be taken. This is particularly evident in the process of standard-setting which, far from being purely scientific, turns out to be a microcosm where conflicting epistemologies, regulatory philosophies, national traditions, social values and professional attitudes are reflected (G. Majone, 1984).

The case of standard-setting also shows that the definition itself of the boundaries between science and trans-science and between science and policy is controversial and socially bounded (S. Jasanoff, 1987). It is quite difficult to define, for instance, the border where science stops and politics enters in determining which air or water quality standards are suited to protect health and environment. Scientists belonging to a particular school, country or discipline may consider "not scientifically sounded" what is suggested by other scientists (Brickmann-Ilgen-Jasanoff, 1985; G.Majone, 1983), and this demonstrates that scientists are

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"socially situated reasoners" (K. Knorr-Cetina, 1981) and not bearers of truth.

This is a problem for policy makers who would need clear answers and uncontroversial numbers as a basis for regulation, particularly in fields like environment and health protection. In fact, apart from the cases where scientific uncertainties or disagreements between experts may be used as a good excuse for delaying or blocking undesired decisions, the necessity to deal with such uncertainties and controversies adds difficulties to the already complex political and legislative regulatory process.

Two points shall be made with respect to this problem: on the one hand policy makers cannot avoid dealing with scientific uncertainties; on the other hand proper utilization of the available knowledge and encouragement of research in not sufficiently explored policy-relevant fields are important basis for policy and regulatory decisions.

Regarding the first point, it shall be noted that uncertainties are unavoidable, especially in emerging or particularly complex research areas, and attempts to hide uncertainties -or even ignorance- can provoke crisis of experts' and politicians' credibility when unexpected events like the Chernobyl accident and fallout unmask such attempts (W. Krohn - P. Weingart, 1986; A. Liberatore, 1987; B. Wynne, 1989). And apart from credibility problems, informed decisions (as policy decisions are usually assumed -or hoped- to be) should imply an examination of the quality of the available information (R. Costanza - S. Funtowicz - J Ravetz, 1988) or the lack of reliable information.

In this respect, the actors of research -that is scientists (including social scientists) and research managers- should be able to provide both basic research which can be useful in the long-term and may help in directing policy choices, and knowledge "usable" in the short and medium-term that can be helpful for implementing policy actions. On the other hand, policy makers can

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have a positive role in promoting the gathering, sistematization and harmonization of available data and studies, and in encouraging the development of research concerning topics relevant for policy and regulatory purposes.

Some recent developments in EC environmental policy and research seem to go in this direction. But before examining them, it seems advisable to see what are their antecedents.

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3. THE FOUR ENVIRONMENTAL ACTION PROGRAMMES AND THE ENVIRONMENTAL RESEARCH PROGRAMMES: DISJOINED OR CONNECTED ?

Looking at the areas suggested in the two Council decisions adopting for the first time direct -i.e. to be conducted within the JRC- environmental research (O.J. L 153, 9.6.73 and O.J. L 189, 11.7.73) it emerges that environmental policy and research not only started in parallel but were also -at least partially- connected.

For instance, one of the areas covered by the first Environmental Research Programme (from now on, ERP) regarding direct research[1], is the formation of a data bank for chemicals which is connected with the Directive of 1967 on dangerous substances and with all the regulatory activities concerning pollution due to chemical products. Moreover the research activities (also included in the first ERP) concerning teledetection and measurement of pollution were directly relevant for the choice of measures aimed

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1. There are different decisional procedures (due to the fact that most research programmes conducted within the JRC falls under the Euratom instead of the EEC treaty) for the approval of Environmental Research Programmes regarding direct or in-house (i.e. conducted within the JRC) research and indirect research (i.e. conducted by research institutes of the member States on the basis of cost-shared contracts where the Commission -DG XII- pays 50% of the actual costs). Researches which are coordinated but not funded by DG XII, or at the EC level or involving non-EC countries (the previously mentioned COST agreements) are included in the programmes on indirect actions. To avoid confusion, in the text it is specified for each ERP if it refers to direct or indirect actions.

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at reducing pollution and nuisances as indicated by the first Environmental Action Programme -EAP- (O.J. C 112, 20.12.73). These two examples seem also to reveal that the initial connection between environmental policy and environmental research was based on a sort of unidirectionality, that is research was asked to provide an informative basis for previously decided actions (policy -> research) but it was too piecemeal to provide also inputs to direct policy making in the choice of areas/issues to be addressed (research -> policy).
Has the situation changed after the adoption of more comprehensive Environmental Research Programmes ?

3.1. A comparison between the programmes.

In analyzing the relationships between EC environmental policy and EC environmental research as they emerge from the respective programmes, I will take into account four dimensions: **curative** and/or **preventive** approach; **short-term** and **long-term perspective**; **sectoral vs multi-media** approach; **costs and benefits** of environmental regulation and research[2].

The first EAP refers explicitly and extensively to the use of scientific and technical knowledge as a basis for environmental regulation in two chapters: chapter 10 on "Research Projects Concerning Protection of the Environment" and chapter 11 on "Dissemination of Knowledge Relating to Environment Protection". Moreover, Annex 2 shows the research projects adopted in the first ERP (direct, cost-shared and coordinated actions) in relation to

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2. For a detailed analysis of these dimensions see, A. Liberatore (forthcoming).

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the various items of the EAP, and containts suggestions for future research also considered useful for those items, especially for the setting of environmental, health and product standards. The suggestions for further research can be grouped in four areas: 1. the development of anti-pollution technologies and measurement methods, that is technical tools for implementing regulatory measures; 2. short and medium term scientific research on specific, sectoral problems (acustic irritants, thermal rejects, marine pollution from the continent) to support actions on such problems; 3. few long-term researches (particularly important the suggestion to develop research on the structure and functioning of ecological systems) to orientate environmental policy; 4. research on socio-economic issues (restricted to research to be conducted by the newly established European Foundation for the Improvement of Working and Living Conditions on changes in the urban and working environment).
Long-term and socio-economic research are relatively underrated in these suggestions, probably because that initial stage was mainly characterized by a curative approach of environmental regulation (i.e. regulation aimed at repairing or reducing the widespread damages and pollution) and the urgency was felt of concentrating on short-term usable knowledge.

The Second ERP (indirect action) for the period 1976-1980 refers in turn to the first EAP and declares as main aim of the research "to acquire the scientific and technical know-how necessary for implementation of the environmental programme of the Community" (annex, O.J. L 74, 20.3.76). Some of the above mentioned suggestions are reflected in the four research areas selected: research to establish criteria (exposure/effect ratios) for pollutants and toxic chemicals; environmental information management, with particular reference to chemicals (ECDIN project); reduction and prevention of pollution and application of

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"clean technologies"; protection and improvement of natural environment.
The organization of the programme then is still focused on short and medium term research (even if long-term research can be required especially with regard to the fourth area) and reflects the need to continue the building up of criteria, methods and basic information useful for implementation of environmental regulation.
In order to avoid misunderstanding it shall be stressed that the distinction between short-term and long-term research does not imply that the two are separate (even in long-term projects there are short-term aspects of research, and short-term projects may give rise to long-term ones) but indicates that different timing and organization of work are necessary to produce -and utilize- results.

A shift towards a more preventive approach can be found in the second EAP.
In fact -beside the continuation of "curative" actions- the programme dedicates one title to the "non-damaging and rational management of land, the environment and natural resources", where the development of an ecological mapping system is envisaged, and one title to "general action to protect and improve the environment", where the Environmental Impact Assessment is mentioned for the first time (O.J. C 139, 13.6.77).
Due to the economic stagnation of the years following the oil crisis of 1974, the analysis of economic -and social- aspects of environmental actions is stressed and an examination of the possible economic benefits of environmental actions is suggested in order to demonstrate the feasibility -beside the necessity- of continuing environmental policy also during economic crisis.
Regarding this point a crucial methodological (but also political) problem is underlined, "The benefits of an

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environmental policy are a reduction in the social costs of pollution and an improvement in the quality of the environment. Their evaluation in monetary terms poses very complex and difficult problems, primarily because of the subjective nature of a large number of the factors involved" (C 139/37).

No trace of this interest -and need of analysis- in the economic and social problems connected with environmental policy can be found in the third ERP, indirect actions (O.J. L 101, 11.4.81). The reseach programmes are designed taking into consideration only "purely" scientific and technological elements and give no space to studies coming from the social sciences. Even if pollution is caused by human activities, its political, social and economic context is left out of the analysis.
Continuity with the second ERP and an increased attention towards long-term research are represented by the two independent sub-programmes of the third ERP. The sub-programme on Environment Protection continues and enlarges the previous researches, while the sub-programme on Climatology starts long-term research on climate modelling and prediction and on man-climate interactions. In the third ERP, the increase of the funds allocated for environmental research is also remarkable: from 16 million ECU for the second ERP, to 42 million ECU for the third one (34 million for the programme on Environment Protection and 8 million for the newly introduced Climatology programme).

Integration of the environmental dimension into other policies, introduction of environmental impact assessment procedures and reduction of pollution and nuisance at source are the main elements of the third EAP (O.J. C 46, 17.2.83). Particularly concerning the last point, it is stressed in the programme the importance of technological development, "Preventive action designed to reduce pollution at sources will, wherever possible,

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gradually replace attempts to control the effects of pollution and nuisance. The development of new production technologies and the design of new products will not only help make the management of natural resources more efficient but will also form a major element in the prevention of pollution" (p.12).
The integrative and preventive approach (which implies a long-time perspective, without excluding short and medium-term actions) are also emphasized in the fourth EAP (O.J. C 70, 18.3.87). Moreover the need is stressed to move from a sectoral, that is media specific, to a multi-media approach which takes into account the interconnections between the different environmental media (water, air and soil) instead of taking them separately. Separation involves in fact the risk of deciding measures that shift pollution from one media to another instead of combating it.

The multi-media approach requires interdisciplinary research on the structure and functioning of ecosystems, research which had been already suggested in the first EAP and which was included in the fourth ERP (O.J. L 159, 14.6.86).
The fourth ERP contains two quite important elements: a closer link between direct, indirect and coordinated research, and a new research area.
Starting from the approval of the first Framework Programme for Community research, development and demonstration activities in 1983 (O.J. C 208, 4.8.83), direct and indirect research are more closely connected, even if the respective programmes are still decided with separate procedures. In the proposal of the fourth ERP such connection is explicitly mentioned (O.J. C 301, 25.11.85: p.14), and the activities of the JRC are referred to with special regard to the newly introduced pilot project on Major Technological Hazards. In fact this project, which is directly related to the Seveso Directive on major accidents hazards of industrial activities, continues (on a small scale: 3 million ECU

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are allocated for it against 55 million ECU allocated for the Environment Protection programme and 17 for the Climatology programme) the shared-cost activities conducted within the JRC - Ispra Establishment- under the 1979-1983 nuclear safety programme and then included in the direct programme on industrial risk covering the period 1984-1987. The area of major technological hazards is also the only one where social aspects and research are directly addressed: risk assessment, risk management and risk perception are mentioned beside the strictly technological engineering aspects, and issues in risk communication and -more generally- on public information and participation have been recently addressed within such programme (EC Conference on "Communicating with the Public about Major Industrial Hazards", 1989).
One chapter that looked quite interesting from the point of view of the links between environmental research and environmental regulation was described in few lines in the sub-programme on Environment Protection of the fourth ERP: it regarded "The scientific basis of environmental legislation" and was aimed at organizing "catalytic activities" to facilitate the use of scientific results for environmental regulation. But this chapter has then disappeared.

3.2. Some trends .

The main objectives of the fourth ERP have been stated as follows (O.J. C 301/3): a. to establish a scientific basis for the implementation of the Community's environmental policy; b. to promote long-term basic research on important ecological problems; c. to coordinate relevant national research in selected and suitable areas.

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Continuing the approach underlying the third ERP, the sub-programme on Environment Protection addresses short and medium-term policy goals as far as research requirements are concerned, and the new pilot project on Major Technological Hazards is aimed at producing research on issues directly relevant to the Seveso Directive. The sub-programme on Climatology addresses instead more long-term issues connected with the effects of human activities on climate.

This "division of roles" is even more emphasized by the presentation of two separated programmes in the environmental field for the period 1989-1992: the programme on Science and Technology for Environmental Protection -STEP-, which continues the previous Environment Protection and Major Technological Hazards programmes, and the European Programme on Climatology and Natural Hazards -EPOCH- which continues the Climatology programme (COM (88) 632 final - SYN 168). It should be noticed that such a division of roles regards not only the content -and time span- of the programmes but also their organization in terms of utilization of in-house resources and collaboration with international organizations. While the STEP programme can rely on the improved (through coordinated and cost-shared activities going back to the early seventies) European scientific networks in the environmental field and on the reorganized activities of the JRC (especially the recently established Institute for the Environment based in Ispra)[3], the EPOCH programme cannot take

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3. During 1988 and 1989 the JRC has been reorganized and nine research institutes have been established: The Central Bureau for Nuclear Meausrements in Geel, the Institute for Transuranium Elements in Karlsruhe, the Institute for Advanced Materials in

(Footnote continues on next page)

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much advantage from in-house research and has to rely on a more recently organized European scientific network and on a broader international collaboration (for instance, with the World Metereological Organization).
It seems therefore that the process of "europenization" of environmental research is following different paths depending on the research sectors, and this is partially due to the previous history of EC research policy which facilitated the development of areas where it was easier to re-utilize the available (ex-nuclear) facilities and knowledge. Moreover both short-term and long-term research aimed at helping in implementation of environmental policy and at directing it are taken into consideration in the last ERP.
As far as relatively recent trends of environmental policy are concerned, it should be pointed out that the EC is increasing its activities within international organizations like UNEP (United

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Petten, and the Institute for System Engineering, the Institute for Safety Technology, the Centre for Information Technologies and Electronics, the Institute for Prospective Technological Studies and the Institute for the Environment in Ispra. The Environment Institute started working of four topics already included in the previous environment programme of the JRC: environmental chemicals, air pollution, water quality and chemical wastes. On special request of the European Parliament and the Council four new topics were added: European Monitoring Network, Environmental Studies for the Mediterranean Basin, Food and Drug Analysis, Genetically Engeneered Substances. While the first of the new topics -and partially the second one- are closely connected with the previous activities of the JRC, and the third one is new but not outside the sphere of scientific competences already existing within Ispra, the research on biotechnology should be started from zero and this involves serious problems.

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Nations Environment Programme) and also its participation in international conventions and agreements like the Barcellona Convention on the Protection of the Mediterranean Sea, the Vienna Convention and the Montreal Protocol on protection of the ozone layer and others.

In parallel to this internationalization of Community's environmental action, there are projects aiming at its "regionalization" (for instance, the MEDSPA plan on actions concerning the Mediterranean region), that is establishing specific actions for areas sharing similar environmental conditions and threats.

These two strategies are not in contrast but correspond to different scale of the problems to be faced and to the necessity to find the appropriate level of action in order to improve the implementation of environmental policy.

In the following chapter the attempt is made, through the analysis of some Directives, to analyze what is the actual contribution and utilization of EC environmental research for regulatory measures aimed at repairing or preventing global and regional environmental degradation in the short and in the long-term.

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4. EXAMPLES OF THE INTERPLAY BETWEEN KNOWLEDGE AND DISCRETION: ANALYSIS OF SOME ENVIRONMENTAL REGULATORY ACTIONS.

Since the adoption of the first EAP an impressive number (around 150) of Directives in the environmental field have been approved. Directives are only one of the legal instruments available at Community level. According to article 189 of the EEC Treaty, the Community may use five main forms of actions: 1. **regulations**, which have general application, are binding in their entirety and are directly applicable in all member Sates; 2. **directives**, which are binding only as to the result to be achieved leaving the national authorities the choice of forms and methods of application; 3. **decisions**, which are binding in their entirety upon those to whom they are addressed (member Sates, legal person, private institutions and individuals); 4. **recommendations** and **options** which have no binding force; 5. **resolutions** and **declarations**, which may be adopted by the Council of Ministers and have political nature.

The use of Directives as a main instrument of environmental policy means that EC environmental law can be applied in a flexible way by adapting to existing national legislation and administrative practices. But the price is that the Directives may be applied in a quite varied manner at the expenses of policy coherence; moreover, and even worse, it has been pointed out that lax implementation and non-compliance grow as the number of Directives arise (I. Koppen, 1988; L. Kraemer, 1988; E. Rehbinder - R. Stewart, 1985; E. Von Weiszaecker, 1988).

Environmental Directives are mainly "regulatory-type" Directives (E. Rehbinder - R. Stewart, 1985) and may take different forms: prohibition of polluting activities; emission, specification and

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input standards; testing, packaging and labelling obligations; or they may set environmental quality standards leaving the member States a wide discretion in applying them to individual polluters.

Some issues regarding the utilization of knowledge in formulating and implementing environmental Directives and other regulatory actions are addressed in the following pages, particularly:
1. the resort to EC or to "external" research in EC regulatory process, and the relationships between the EC and the broader international dimension of environmental policy and research;
2. the management of scientific uncertainties and the selection of relevant information in policy-making;
3. the use -or neglect- of social sciences beside the natural ones;
4. the impact of regulatory provisions on scientific practices and, vice versa, the impact of research methods and results on regulatory actions;
5. the "time gap" between the time needed to reach sound scientific results and the necessity to take timely (timely for environment or timely for politicians: unfortunately the two perspectives do not always overlap) decisions.
From a more general point of view, the different ways in which these issues can be linked are examined taking into account the relationships between knowledge and discretion in policy making. As it was previously argued, the scientific basis required for regulatory purposes is usually uncertain and controversial, and the border where science stops and political judgements enter the arena is not clear-cut.
In the words of an eminent scholar, " Relevant knowledge is almost always insufficient to permit definitive conclusions about the consequences of policy options. Moreover, even complete knowledge would almost never be a sufficient basis for policy choice: decision-makers cannot escape exercising discretion based on their

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values and policy orientations and on political considerations." (T. Greenwood, 1984: p.1).

Therefore there is an interplay between (uncertain) knowledge and administrative discretion, defined (according to T. Greenwood, 1984: p.3) as " the power or right to decide or to act on either procedural or substantive matters according to one's own judgement or choice".

In the EC context, the interplay between knowledge and discretion may take different forms depending on the level and the content of the decisions to be made and on the degree of uncertainty in the scientific basis. At the level of the EC Commission and the EC Council, such interplay may take the form of negotiations about the interpretation -in the light of political and economic controversies between the member states and within the EC institutions on a given subject- of the scientific evidence and experts' advice required for deciding about regulatory measures. At the national level, this interplay can take the form of negotiations about the interpretation and the methods of implementation of EC regulatory actions within each Country. Within these negotiations, discretion supplements, selects and interprets knowledge and the rules governing knowledge utilization: for instance, the clauses regarding the adaptation of regulatory measures to the scientific and technical progress or the adoption of the best available technology. On the other hand, knowledge constraints discretion by offering data and explanations that cannot be completely ignored (even if -or especially if- they are controversial), at least because EC actions can be challenged by international bodies and by members states -and members states' actions can be challenged by opposition groups and by EC institutions- on the basis of the available knowledge.

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Six cases are examined in the next paragraphs, starting from the "oldest" EC environmental Directive and concluding with a regulatory action which is still in the realm of possibilities. After a reconstruction of the various cases, their peculiarities and their common features will be discussed at the end of this chapter.

4.1. " Dangerous for the Environment".

The Directive of 27 June 1967 on classification, packaging and labelling of dangerous substances was the first environmental regulatory measure adopted by the Community institutions and represents a sort of keystone - in continuous development - of EC environmental policy. It seems therefore fair to start from it, or better from its **Sixth Amendment** approved in September 1979 (O.J. L 259, 15.10.79).

The point of departure of the present analysis is the most obvious one (at least apparently), that is the definition of "dangerous" substance. Article 2 of the Sixth Amendment lists the substances and preparations regarded as dangerous: explosive, oxidizing, extremely flammable, higly flammable, flammable, very toxic, toxic, harmful, corrosive, irritant, dangerous for the environment, carcirogenic, teratogenic, mutagenic. "Dangerous for the environment" are defined the "substances and preparations the use of which presents or may present immediate or delayed risks for the environment".

The interesting problem is that the definition of criteria to classify substances as " dangerous for the environment" remained quite controversial till 1989, i.e. ten years after the adoption of the Directive. And this seems particularly surprising given the very detailed technical requirements contained in this piece of legislation.

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Article 3 prescribes that, "the real or potential environmental hazard shall be assessed according to the characteristics set out in Annex VII and VIII, on the basis of any existing internationally recognized parameters". Annex VII includes a reference to ecotoxicological studies, that is studies mainly regarding effects on organisms to be verified by means of tests of acute toxicity for fish and daphnia (a water organism). Article 3 refers then to Annex VI for the general principles of the classification and labelling of substances. But Annex VI does not include criteria to classify a substance as "dangerous for the environment".

Then the Commission -DG XI- asked the Scientific Advisory Committee to Examine the Toxicity and Exotoxicity of Chemical Compounds [5] to qualitatively and quantitatively characterize criteria to be selected to define substances and preparations dangerous for the environment for inclusion in Annex VI.

After a first communication on the subject in 1982, the Committee submitted in 1985 a document where the following principles for classification were suggested: 1. the acute toxicity tests for fish and for daphnia (included also in Annex VII of the Directive) and for mammals have to be considered; 2. all the substances which are found to be "very toxic" to mammals, fish or

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5. The Scientific Advisory Committee to Examine the Toxicity and Ecotoxicity of Chemical Compounds (established in 1978) consists of 22 members: 18 senior experts from member states and 4 representatives from the Commission. It is one of the permanent advisory committees attached to the Commission (in this case to DG XI) and has the task of supplying her -at the latter's request- with opinions on matters related to toxicity and ecotoxicity of chemicals taking into account the scientific knowledge available.
Other Committees of such a nature are the Scientific Advisory Committee for Food and the Scientific Advisory Committee on Cosmetology.

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daphnia are to be classified as dangerous to the three compartments of environment, i.e. soil, air and water; 3. the classification of less toxic substances must include properties like the Potential Environmental Distribution (PED), the persistency, bioaccumulation and toxicity of the substances. Then separate indicators of ecotoxic effects of a substance in each compartment are suggested: acute toxicity test on fish and daphina for water, acute toxicity inhalation test on rats for air, acute toxicity oral rat or acute toxicity daphnia test for soil.
Taking into account the advice of the Committee and after consulting member states' authorities, the competent unit within DG XI made a first proposal which was debated in a meeting with member States authorities in 1987. The Commission proposal was slightly different from the one of the Committee and was based on water organism tests (the ones included in Annex VII) because air organism and soil organism tests are not available or not yet standardized at the international level. During the meeting the need was expressed to discuss at a later date what additional information would be required for the air and terrestrial compartments.
At a second meeting the Commission suggested to amend article 2 of the Directive by defining as "ecotoxic" (dangerous for the environment) substances and preparations which present or may present immediate or delayed risk " for one or more compartments of the environment " (instead of " for the environment"); one delegation suggested instead two separate classification categories, one for the aquatic and one for the terrestrial environment. Regarding the kind of tests to be used, another delegation suggested to introduce also algae tests and, together with other delegations, criticized the Commission proposal for suggesting too lax threshold toxicity values which were instead considered appropriate by representatives of industry.

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Decisions concerning both these issues were postponed to a third meeting (held in 1989), where threshold values were raised thanks to the changed position of some other member states, and where the following criteria were agreed upon: 1. to classify substances only on the basis of acute aquatic toxicity for fish and daphnia, plus acute toxicity for algae; 2. to combine acute aquatic toxicity with lack of ready degradability or with high potential of bioaccumulation for readily degradable substances. Finally, risk phrases to accompany the classification "dangerous for the environment" were agreed in which it is possible to specify if the substance is very toxic, toxic or harmful for organisms (with possibility of prolonged or delayed effects) in each of the environment compartments.

Uncertainties due to the lack of standardized testing methods for soil and air organisms were then the basis of scientific controversy and political negotiatiation. Scientific controversies are not solved (proponents of inhalation or oral acute toxicity tests on rats may still argue that it is better to extrapolate ecotoxicity from such tests than to rely exclusively on aquatic organisms tests), but a decision on criteria to classify substances as dangerous for the environment has been reached on the basis of partial consensus on the available scientific basis and especially thanks to the changed - more "green" - attitude of some members states that decided to favour the option which makes possible to encompass as many "suspected" substances as possible. If a more "moderate" approach had prevailed, more stringent criteria (for instance, leaving out algae tests or mixed criteria like acute toxicity-lack of ready degradability) and lower threshold values would have been approved and well-known toxic substances like cadmium and HCB would have escaped the classification.

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In this case then political prevailing attitudes made the scales tip in favour of a "green" pragmatical adjustment of scientific uncertainty: that is, better to find a way to include in the classification well-known toxic substances like cadmium than to leave them out and be accused of biased (pro chemical industry) decision.
Certainly the case cannot be generalized: in face of scientific uncertainties the attitudes more protective towards the environment not always prevail. And in fact some of the member states (for instance, U.K.) that were among the "greens" in this occasion, have been among the moderate ones when not "mere" classification but constraints on industry practices, for example in the field of air pollution control (the Directive on sulphur dioxide being a case in point), were at stake.

4.2. Testing methods and animal welfare.

The scientific uncertainties that emerged in the debate about the definition of ecotoxicity criteria, uncertainties mainly due to the lack of internationally standardized and validated testing methods for soil and air organisms, will be maybe solved after some years of research. In this respect, DG XII is promoting - within the STEP programme- research on the assessment of ecological effects of chemicals including the development of test methods for the terrestrial and marine environment, the development of field and laboratory tests to predict the cross-media effects from chemicals, and the improvement and validation of models linking laboratory data to estimated exposure and effects in the environment (paragraph 2.4).
But in the meantime, a crucial problem regarding testing methods which are routinely used to detect effects of chemicals on human health (for instance, tests to predict carcinogenic effects) is

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arising, that is the problem of the protection of animals used for experimental purposes.
The issue of animal welfare is no more restricted to the area of environmentalists working in very active non governmental organizations like FRAME (Fund for the Replacement of Animals in Medical Experiments) which is also editing a scientific journal on Alternatives To Laboratory Animals (ATLA). Recently that issue entered the legislative area: it is dealt with by the legislation of some Countries and by a specific EC Directive adopted in 1986 on the **protection of animals used for experimental and other scientific purposes** (O.J. L 358, 18.12.86).
This Directive does not restrict (a part from the prohibition to use animal considered as endangered, art. 4), but only regulate animal experimentation by setting minimum common standards on animal accomodation and care. However, article 23 of the Directive states that " The Commission and Member States should encourage research into the development and validation of alternative techniques which could provide the same level of information as that obtained in experiments using animals but which involve fewer animals or which entail less painful procedures". That is, the Directive encourage the research on reduction alternatives, which reduce the number of animals, and refinement alternative, which diminish the pain suffered by animals. But it is also possible to suggest replacement alternatives aimed at replacing animal experiments with **in vitro** tests. Research on the first two alternative methods is promoted within the fourth ERP and in the STEP programme, while the research on replacement alternatives is promoted by the EC Biotechnology Action Programme (EC Commission, BAP. Progress Report, 1988) and by the Toxicology Action Programme.

Regulatory and scientific problems related to the development of alternative testing methods are pointed out in the " Report to the

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Council on the possibility of modifying tests and guidelines laid down in existing Community legislation in compliance with Article 23 of Council Directive 86/609/EEC" (COM (88) 243 final).
Concerning regulatory aspects, the Report underlines that several pieces of Community legislation explicitly or implicitly require animal testing to be carried out. Usually this requirement takes the form of guidelines which are included in the legislative test, as in the case of the previously analyzed Sixth Amendment or in the case of pharmaceuticals (Council Recommendation 87/176/EEC), or have a separate status like the ones elaborated by the Scientific Advisory Committee for Food ("Guidelines for the Safety Assessment of Food Additives") and by the Scientific Advisory Committee on Cosmetology ("Notes of Guidance for the Toxicity Testing of Cosmetic Ingredients").
The problems to be faced by regulators and scientists with respect to the development of alternative testing methods are therefore the following ones: 1. how to make comparable animal and in vitro tests in order not to remake all the tests conducted, and mutually accepted at the international level, until now ? 2. How to validate new methods not only at the scientific but also at the regulatory level taking into consideration criteria like cost effectiveness, repeatability, time needed for the experiments, etc.? Moreover, in vitro tests can provide toxicity data observations but they do not provide values, therefore they may be very useful for screening (for example, in the field of pharmaceuticals) but it does not seem feasible to use them - instead of animal experiments- in order to test carcinogenic effects of substances.
Also in this case scientific uncertainties and political (and ethical) considerations are intermingled: animal welfare is a political and ethical issue -not a scientific one- involving other political and ethical issues (is human health the most important "good" to be protected? Is it possible to determine an acceptable

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number of animals to be used for experimentation? And what about all the experiments - which represent the 80% of animal experimentation - conducted by industries and universities ?). Once accepted as a political, ethical and legal issue, animal welfare involves possible changes in experimental practices- which in turn may influence regulatory practices.
How will this influence take place is still an open question.

4.3. Biotechnologies.

In 1978 the EC Commission submitted to the Council of Ministers its first proposal for a Directive establishing safety measures for recombinant DNA work. But restricting scientific inquiry revealed to be politically too contentious and the proposal was rejected (R. Holla, 1989).

Four years later [6] a Recommendation was instead approved on the registration of work involving recombinant deoxyribosenucleic acid (O.J. L 213, 21.7.1982) where a notification procedures was recommended to register laboratories wishing to undertake work involving recombinant DNA techniques. And in 1984 the Commission decided to establish the Biotechnology Steering Committee (BSC) to coordinate its activities in the biotechnology sector. The BSC is supported by the Concertation Unit for Biotechnology In Europe (CUBE) -based in DG XII- which provides information on scientific developments in biotechnology, and by some interservice working groups (that is, groups formed by officials of different Directorate Generals and working on a specific subject for a certain period). The working group dealing with regulatory aspects is the Biotechnology Regulations Interservice Committee

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6. For a more detailed account of the history of biotechnology regulation in Europe see R. Holla, op.cit.

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(BRIC) which activities resulted in the drafting of a "Regulatory Framework for the Use of Genetically Modified Organisms" consisting of two Commission proposals for Council Directives.

What is particularly interesting in the context of the present study is that the proposed regulation is aimed at regulating research practices and outcomes. The two Directives address in fact two different but connected aspects/stages of biotechnology research.
The first one regards the " **contained use of genetically modified micro-organisms** " (O.J. C 198, 28.7.88), that is "any operation in which micro-organisms are genetically modified, cultured, stored, transported, destroyed or disposed of and for which physical, chemical or biological barriers are used to limit their contact with people and the environment" (article 1). Laboratories -within public research institutes or within industry- are the places where the initial operations (modification and culture) which give rise to all the others are conducted; therefore laboratories'personnel -scientists- are the first subject and target of regulation: subject in the sense that they must comply with and target in the sense that they are protected by regulation (if implemented). Moreover this Directive, by covering also storage, transport and waste destruction or disposal, try to protect a wider public and the environment from **accidental** releases of micro-organisms. After the catastrophical accidents occurred in sectors like the chemical and the nuclear one, it seems that a "regulatory learning" (from experience and from the results of previous regulations) is occurring and that policy-makers are (wisely) taking into account the possibility of accidents also in other sectors like biotechnology.

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The second Directive deals with the " **deliberate release to the environment of genetically modified organisms** " (O.J. C 198, 28.7.88). The intentional, deliberate introduction of genetically modified organisms (GMO) into the environment is also part of the research process before becoming an industrial operation (it is at least hopeful that research precedes, and not only accompanies or follows, large-scale operations). And in most cases it is a " a necessary step in the development of new products derived from or containing genetically modified organisms " (introduction of the Directive, p.19), that is a necessary step in a research process which goes beyond laboratories.

Both these Directives requires the assessment of the risks associated with genetically modified organisms and micro-organisms. Given the uncertainties regarding the scale and nature of these risks, the first Directive suggests a case-by-case approach according to which particular attention must be given to operations using certain genetically modified micro-organisms. The instruments for this case-by-case assessment are the notifications to be submitted by users of micro-organisms (art.8 of the Directive on "contained use ") and by persons willing to undertake deliberate releases of GMO (art. 4 of the Directive on "deliberate release") to the national competent authorities. These authorities in fact shall evaluate, on the basis of the notification submitted, the risks involved and the adequacy of safety and emergency response for each deliberate or (potential) accidental release. But the "competent authorities" of different member states, and the scientists advising them, may disagree in evaluating risks, therefore the proposed legislation provides for

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a form of administrative discretion.[7] In fact article 14 (a quite controversial one) of the Directive on the "deliberate release" establish that a member States may provisionally restrict the use or sale of a product on its territory if there is evidence that such product constitutes a serious risk to people or to the environment. Member states may then exercize (according to this proposal) a sort of "informed discretion" when scientifc controversies provide a ground to take the mentioned precautionary decision.

Risk assessment and risk management are therefore crucial for biotechnology regulation and studies in these fields are necessary to improve regulatory practices. Which means that research is needed also to regulate research.
The problem is that often the actors of research and the regulators have different perception of the problem: scientists rely on laboratory practices and scientific theories and are mainly interested in developing (and obtaining funds for) science, while policy-makers must consider "real life" situations and administrative, economic and political constraints. Then it can happen that these different perceptions may lead to completely different evaluation of hazards, as it is shown by the "Lamming

7. This is far from being an exception. As it was already pointed out at the beginning of this chapter, not all the EC regulatory actions have the same binding force, and Directives explicitly leave to the national authorities the possibility of exercizing administrative discretion regarding the choice of forms and methos of implementation.

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Report" case[8]: for scientists relying on the assumption that good practice in the use of animal growth hormones would prevail, these substances were safe; while for public-interest representatives and regulators this very assumption was highly questionalble (B. Wynne, 1989; J. Ravetz - J. Brown, 1989).

Recently the need to develop risk assessment research has been stressed in the "Communication by the Commission on the revision of the multiannual research programme for the EC in the field of biotechnology (COM (87) 481 final)" where it is stated that " This sector (risk assessment), presently very small in the programme, needs to be strenghten because it is through common research on the pathogenicity, toxicity and the potential disruptive effects of new genetic diversity that a scientific basis will be created for the establishment of efficient regulation " (pp.4-5). Moreover, in the proposal (COM (88) 806 final) of the new biotechnology programme BRIDGE -Biotechnology Research for Innovation, Development and Growth in Europe- covering the period 1990-1994 a section on "safety assessments associated with the release of genetically engineered organisms" has been included. Safety assessment -which is considered part of the "pre-normative research" (i.e. research for regulatory purposes) in biotechnology- will be performed through monitoring, control and assessment techniques, acquisition of fundamental knowledge on gene behaviour and on survival of released organisms, and through novel construction (for instance, engineered

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8. In 1984 the EC Commission asked one of its expert advisory committees to assess the safety of five bioengineered animal hormones. In 1985 the Lamming Committee stated that two hormones were of uncertain safety while the other three were acceptable under certain conditions. For an interesting analysis of this case from the point of view of the implicit "naive sociology" assumptions of scientists see B. Wynne, 1989.

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organisms which can be destroyed in the environment by known and specific techniques).
These are certainly crucial contributions offered by EC research to EC policy. But the scientific basis needed for regulatory purposes should also include research on the social, political and economic impact -and context- of biotechnology.
In fact the evaluation and management (including regulatory actions) of technologies, and of the risks they involve, are processes taking place in an organizational context which makes major accidents "normal" (C. Perrow, 1984) and in a large "experimental field" called "society".

4.4. Acid rain and sulphur dioxide.

The acid rain issue is born in Europe, both at the scientific and at the political level[9].
In 1892 Angus Smith first described the acid rain phenomenon in his book "Air and Water: The Beginnings of a Chemical Climatology". And another british scientist, Eville Gorham, published a series of papers -starting from 1955- that brought acid rain to the attention of other scientists. Gorham was also the first scholar who associated the phenomenon with distant, as opposed to local, air pollution. And this is quite ironic in the light of the following events, when other British scientists tried to demonstrate that it was impossible that sulphur dioxide (SO 2) emissions produced in UK could reach Sweden and provoke environmental damages there.
If the scientific issue is born in UK, the political issue had in fact begun in Sweden. In 1971 public pressure -favoured by the

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9. For a careful account and analysis of the history of the acid rain issue in Europe, USA and Canada see, G. S. Wetstone, 1987.

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media coverage of the findings of scientist Svante Oden on the acidification of Scandinavian rivers and lakes due to SO 2 emissions from U.K. and central Europe- led the Swedish authorities include a "Case Study on Environmental Impact of Sulphur in Air and Precipitations" (prepared by B. Bolin) among the documents to be presented at the UN Conference on the Human Environment held in Stockholm in 1972. At that Conference, the phenomenon of acid rain became an international issue.
During the seventies a scientific -and political- controversy took place between Scandinavian officials (especially from Sweden and Norway) and officials from UK and FRG: the first ones providing studies and evidence regarding acidification of surface waters due to imported air pollution; the second ones denying that SO 2 emissions produced in their countries (the largest producers of SO 2 in western Europe) could involve such transboundary effects.
In the meantime the OECD undertook a programme on long-range transport of air pollution which findings -published in 1977- offered an authoritative verification of Scandinavian charges.

In this context the EC started to propose and take initiatives having implications for control of the acid rain problem.
In 1976 a **Directive on air quality limit values and guide values for sulphur dioxide and suspended particulates** was proposed by the Commission (COM (76) 48, 25.2.76), and although the standard itself was rather modest, the proposal evoked resistance from several member states, including UK, FRG, France and Ireland. An external event helped the Community to reach an apparently impossible agreement: in 1979 was signed -also by the Community on behalf of its member states- the Geneva Convention on Transboundary Air Pollution (UN/ECE/GE 79-42960). Having accepted (for political reasons like the attempt to improve east-west relationships) the principle of international cooperation in the Geneva convention, and having officially recognized the

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severity of pollution due to SO 2 emissions, EC member states found quite difficult to oppose the above mentioned Directive. Therefore the Directive was finally approved in 1980 (O.J. L 229, 30.8.80).

Some of the apparently "purely technical" points of the Directive are the result of the compromises between knowledge and discretion made necessary by the described conflictual situation. Regarding sampling methods, the Directive allows both the OECD method and the gravimetric method -even if the two are hard to compare- because the German government insisted on being able to continue using the second one (N. Haigh, 1987: p.186). Concerning the limit values for sulphur dioxide, the proposed limit of 120 micrograms per cubic meter (taken as a yearly median figure of daily averages) is roughly half as stringent as the WHO -World Heath Organization- recommended, in spite of the reference to the WHO findings in the introduction of the Directive, and this was due to resistance from UK and France. Moreover France commented that the proposed standards were at once too strict (some French industrial areas did not meet the limit values) and not strict enough (most rural area had a better air quality and limit values could be interpreted as a licence to pollute). As a consequence a derogation provision was included in the Directive allowing time for meeting the values (article 3) till 1993, and article 4 provides for the possibility for member states to fix lower limit values (N. Haigh, 1987: p.184).

In this case then, negotiations conducted within the EC institutions -in the light of the disagreements between member states- about the interpretation of technical controversies concerning sampling methods and limit values led up to technical features of the Directive which make its implementation and effectiveness quite dubious. In 1993 -when the established (quite lax) deadline for accomplishing the Directive is going to expire- the Directive is going to be amended.

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In the meantime serious damages to forests were observed in the Federal Republic of Germany and " the death of the forest" became a major subject of public concern and media attention starting from 1981, when "Der Spiegel" dedicated to "Waldsterben" a dramatic cover story. In 1983 a government survey estimated that 34% of the nations trees had been damaged by air pollution, and following surveys found pollution-induced damages in greater that 50% of trees. The position of the FRG shifted consequently to an aggressively pro-control international position and a stringent domestic pollution control (G.S. Wetstone, 1987). At the EC level this changed position of the FRG heavily influenced the proposal and the adoption of the **EC Directive on the limitation of emissions of certain pollutants into the air from large combustion plants** (O.J. C 336, 7.12.1988)[10]. More in general, it also contributed to the modification of EC regulatory philosophy in the environmental field, from the setting of ambient standards - often controversial and difficult to be enforced - to the setting of emission standards which face pollution at source and are more easy to implement.

Measures to control acid rain are then a "high priority" in the Community starting from the Geneva Convention, and in order to direct its regulatory activity in this field DG XI funded studies aimed at providing information on the acid rain phenomenon and on the potential of policies and technologies for its control. A first study, "Acid rain - a review of the phenomenon in the EEC and Europe", was commissioned by DG XI to Environmental Resources Limited in 1983 to review the state of scientific knowledge. In the study were reported some data that made at least arguable, in

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10. See, N. Haigh (1987) and L. Kramme (1989).

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the light of available scientific evidence, the choice of the guide values for sulphur dioxide included in the Directive of 1980. IUFRO (International Union of Forestry Research Organization) recommended for instance (p. 13) an ambient annual average maximum SO 2 concentrations of 25 micrograms per cubic meter, which was stricter than the guide value - 40 to 60 - provided by Annex II of the Directive. And also the concentrations set as safe by IUFRO were questioned because damages had been observed in areas of Germany where average concentrations of SO 2 were below 25 micrograms per cubic meter (p. 80). Given these and other uncertainties, a central conclusion of the study was that it was impossible to make an overall judgement on the formulation of control actions because of the unknowns and uncertainties in the degree of possible damage being caused by acid pollution emissions. But it is also stressed that some uncertainty will always exist and should not be an excuse for postponement of any action (p.20).
DG XI asked then Environmental Resources Limited (ERL) to investigate ways of evaluating potential Community actions taking into account the gaps and conflicts in evidence. A second study was then conducted by ERL together with Cambridge Decision Analysts and submitted in December 1987: " Acid Rain and Photochemical Oxidants Control Policies in the European Community. A Decision Framework. " In this study costs and benefits of five strategies for EEC-wide control of emissions were examined, together with two no-control strategies included to provide an indication of the increase or reduction in damage which may occur if no Community action was taken. Besides the emphasis on emission control measures, the study stresses again the need to continue research on some specific areas where scientific uncertainty can heavily influence the decision process.
Starting from 1983, that is the same year when the first study commissioned by DG XI was conducted, the Ispra Establishment of

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the JRC -on behalf of DG XI- acts as a Central Laboratory for Air Pollution (CLAP) for the implementation of Directive N.80/779 on limit and guide values for sulphur dioxide and suspended particulates. Moreover in 1983 a symposium was held in the Karlsruhe Establishment of the JRC on, " Acid Deposition, a Challenge for Europe ". In 1987 - the same year of the second study commissioned by DG XI - a major International Symposium promoted by DG XII was held in Grenoble on " Air Pollution and Ecosystems ". These initiatives may be considered complementary: the activities of Ispra's CLAP are short-term ones aimed at improving the implementation of the Directive; the research -and Symposium- promoted by DG XII is a more long-term one aimed at deepening the understanding of the scientific aspects of the problem; the study commissioned by DG XI was more policy-oriented (an aspect missing in the research promoted by DG XII), that is it was conducted to provide decision-makers with a decision instrument where the scientific knowledge -and ignorance- is taken into account together with other elements relevant for regulatory purposes.

But the fact that some initiatives may be complementary does not mean necessarily that they are well coordinated and that their results are properly taken into account. Reading some of the documents coming out from each of these initiatives - where no reference is made to the other ongoing related initiatives - one gets the impression that coordination is not optimal. Concerning the utilization of results provided by direct and indirect EC environmental research, the future amendment of the Directive of 1980 or other regulatory measures in this field will show if and how these results are considered.

4.5. Chlorofluorocarbons.

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If the acid rain issue is born in Europe, the one of ozone layer depletion was raised the first time in the USA in 1974 by two scientists of the University of California, Mario Molina and Sherwood Rowland[11]. As a consequence a scientific debate started concerning the effects of certain substances, especially chlorofluorocarbons (CFCs), on stratospheric ozone, and in 1975 the US Congress directed the National Aereonautics and Space Administration (NASA) to develop a comprehensive program of research, technology and monitoring of the phenomenon. Two years later the UNEP established a Coordinating Committee on the Ozone Layer to review research and give forecasts of ozone depletion. In contrast with these developments of research at the international level, it seems that a study on CFCs was started in the mid-seventies within the JRC -Ispra Establishment (in collaboration with the Italian Air Force), but it was considered not interesting by an experts' committee asked for evaluation of the programme, and then the research was stopped. Maybe a case of underestimation of long-term research ?
In October 1976 the first regulatory action aimed at protecting ozone layer was taken: the US began to place a ban on non-essential uses of CFCs as aerosol propellants and by the end of the seventies also Sweden, Norway, Canada and Australia joined this ban. The Community adopted at that time a more moderate measure. After a first Council Resolution -approved in 1978- calling for a limitation on production of CFCs (O.J. C 133, 7.6.1978), in 1979 the EC Commission submitted a proposal for a **Decision concerning chlorofluorocarbons in the environment** which

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11. For further details on the developing of the issue see, EC Commission, DG XI, Note d'information: La protection de la couche d'ozone et la Communaute Europeenne, 1989; N. Haigh, 1987; NASA, 1988; Saving the Ozone Layer London Conference, 1989: introductory paper; G. Strongylis, 1989; UNEP, 1989; G. Vonkeman, 1987.

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was approved by the Council the following year (O.J. L 90, 3.4.1980) and which provided for a 30 % reduction in the use of CFCs as aerosol propellants (article 1).
This Decision reflected the international scientific concern, filtered through industry concern. At that time there were in fact many uncertainties regarding the magnitude of the ozone depleting potential (ODP) of CFCs and other chemicals, and these uncertainties lead to quite different precautionary measures: ban on non-essential use of CFCs in some Countries and 30 % reduction in their use in the EC. Therefore there is reason to believe that the figure of 30 % was chosen not on the basis of a different (but coming from where if the EC had no independent research on the issue?) scientific evidence, but because it was known that it could be achieved without creating too much difficulty for the industry (see N. Haigh, 1987: p. 267-268).
In 1982 a second Council Decision (O.J. L 329, 25.11.82) consolidated the measures taken in 1980 and asked for actions aimed at reducing CFCs losses and at limiting emissions in the synthetic foam, refrigeration and solvents sectors (article 2). It also provided for a re-examination of the measures to be taken in the light of the scientific and economic data available.
The need to strenghten research efforts at the international level was emphasized in 1985 by the Vienna Convention for the Protection of Ozone Layer; in the Annex I of the Convention it was also stressed that research should regard not only CFCs but also carbon, nitrogen and bromine substances which were also suspected to have negative effects on ozone layer. In the same year research efforts produced alarming results: observations conducted by the British Antartic Survey (which had been studying ozone layer above Antartica since 1957) showed a decrease of 50 % in the ozone over Antartica (the so-called "ozone hole"). Evidence to confirm -at the global level- the connection between CFCs and ozone layer depletion came in 1987 as a result of investigations

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carried out by the Airborne Antartic Ozone Experiment organized by NASA.

These data -together with increased public concern and with the improved readiness of industry to look for alternative products- accelerated the adoption, in September 1987, of the Montreal Protocol on Substances that Deplete Ozone Layer. The Protocol freezes production and consumption of five CFCs at 1986 levels by 1990, reduces them to 80 % of 1986 levels by 1994 and to 50 % of these levels by 1999. Moreover it freezes at 1986 levels also the production and consumption of three halons (calculated to have an ODP between three and ten times higher than CFCs) by 1992. The EC took active part in the consultations leading to the Protocol and transformed the provisions of the Protocol in EC Regulation (i.e. the most binding legal instrument available in the Community) in October 1988 (O.J. L 297, 31.10.88).

The publication in March 1988 of the Report of the Ozone Trends Panel (formed in 1986 by NASA in collaboration with UNEP, WMO and other oganizations and involving over one hundred scientists) offered a new scientific input for further actions. The ground-based observations shows in fact that between latitude 30 and 64 degrees in the northern hemisphere, where most of the world's population live, the total amount of ozone above any particular point had decreased between 1.7 and 3 % in the period from 1969 to 1986 (NASA, 1988). And although all the implications of further depletion of ozone layer for the global environment and human health cannot be fully known at this stage, it is clear that increasing amount of ultraviolet radiation reaching the earth would affect the incidence of certain skin cancers and eyes illnesses, and might negatively influence oceans' ecosystems, plant life and agriculture. In the light of these considerations and of the available scientific evidence, in October 1988 the UK Stratospheric Ozone Review Group published a Report where 85 % reductions in CFC emissions are urged, together with the phasing

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out production of the major man-made carriers of chlorine and bromine to the stratosphere (Saving the Ozone Layer London Conference, 1989).

The Helsinky Declaration on the Protection of Ozone Layer of May 1989 reflects these recent research results and the readiness of some major productors of CFCs to offer some alternative products and to continue efforts to find "ozone-friendly" technologies. The Declaration -signed by the EC Governmenmts- suggests the phasing out the production and consumption of CFCs controlled by the Montreal Protocol as soon as possible but " not later than the year 2.000" (which is not a scientifically based but a symbolic, politically and economically chosen- date), to phase out also halons and to control other ozone-depleting substances, and to develop acceptable substituting chemicals, products and technologies which should be made available also to developing countries. A revision of the Montreal Protocol has been undertaken by four panels that are working on scientific, environmental, technical and economic assessment.

Environmental research funded, coordinated or directly conducted by the Community had no direct role in these scientific and political developments. Which does not mean that research on related issues was completely ignored by the Environmental Research Programmes. Research on man-climate interactions is included in the sub-programme "Climatology" of the third ERP, and it is continued in the "Climatology and Natural Hazard" programme of the fourth ERP with special regard to the climatic effects of carbon dioxide (CO 2). It is now commonly recognized that CO 2 emissions - considered the main cause of the so-called " Greenhouse Effect " - also contribute to ozone layer depletion. On the other hand, it has been demonstrated that also CFCs contribute (for about 15-20 %) to the "Greenhouse Effect". Therefore the research on the climatic effects of CO 2 started at the EC level in 1980 is relevant for the ozone layer problem, and

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the newely introduced research directly related to ozone layer depletion is also relevant for the problem of global warming due to the Greenhouse Effect[12]. This newely introduced research is included partially in the STEP programme, within the topic " Stratospheric Chemistry and Ozone Depletion ", and partially in the EPOCH programme, within the topic " Data Analysis and Modelling in the field of Climate-Ozone Interactions". Moreover a Task Force consisting of a panel of scientific experts and a co-ordinating unit based in Cambridge (UK) has been established in Spring 1989 in order to advice the Commission -DG XII-on the research to be undertaken in the field.
It seems therefore that while EC environmental policy is already integrated in the international efforts to implement measures aimed at protecting ozone layer, EC environmental research will start in the next future contribuing to the international efforts to improve the understanding of the phenomenon and to develop (hopefully before it is too late) substances and technologies which do not deplete ozone layer.

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12. The seriousness of the "Greenhouse Effec" is increasingly recognized at the EC and at the broader international level. A first Report of the EC Commission on "The Greenhouse Effect and the Community", submitted to the Council in January 1989 (COM (88), 656 final), gave rise to a Council Resolution on the same subject in June the same year. In the Resolution is envisaged the analysis of environmental, economic, industrial, energy, social, agricultural and institutional implications of possible measures and technologies aimed at combating such phenomenon.
Unfortunately it is not possible to discuss in this paper also the development of this crucial issue, a part from the brief reference given in the text regarding the connection between such issue and the one of ozone layer depletion. Readers interested in deepening their knowledge on the Greenhouse Effect may start with the above mentioned COM document, and with the Proceedings of the Symposium on " CO 2 and other Greenhouse Gases: Climatic and Associated Impacts " held in Brussels on the 3rd-5th November 1986 and organized by DG XII.

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4.6. Indoor pollution.

Unfortunately pollution does not stop at the door of our houses. Since the early seventies increasing evidence has become available that indoor air in residential and other non-industrial closed environments makes a major contribution (in addition to diet, drinking water, outdoor and industrial workplace pollution) to population exposure to a wide range of environmental chemicals (EC Commission, 1987 Programme Progress Report on Environment Protection: p. 10).

No regulatory measures have been taken till now at the Community level with respect to indoor pollution; and also at the level of EC member states few initiatives has been taken: for example, the recommendations issued by the House of Commons in U.K. on limitation of exposure to radon daughters in dwellings (Hansard, 1987).

Recently the Commission started evaluating the opportunity of regulatory actions in the field of indoor air quality, and in order to assist DG XI in this evaluation three reports on the existing knowledge in the field of exposure to and effects of indoor radon, formaldeyde and nitrogen dioxide have been planned. These reports are the result of direct research - a research programme on indoor air pollution has been conducted in Ispra starting from 1981 - and of research conducted in the framework of a COST project on "Indoor Air Quality and its Impact on Man" that started in March 1987. The project is managed by the JRC at Ispra and involves two non-EC member states, Switzerland and Norway. Moreover, contacts are established with NATO (which started a pilot study on indoor air quality) and the Regional Office for Europe of the World Health Organization (EC Commission (1989), Environmental Research Newsletter, n. 3).

Concerning radon, which is a naturally occurring radioactive gas, the International Commission for Radiological Protection (ICRP)

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issued some recommendations in 1984 for limiting the exposure of members of the public to enhanced radiation concentrations, and the UN Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) is reviewing risks from radon radiation exposure. As mentioned in a previous chapter, the assessment of radiation risks can be regarded as a "trans-scientific" problem. But in spite of the uncertainties inherent in the limited epidemiological and dosimetric studies used as a basis for this assessment, radon radiation risk is approaching the regulatory arena.
A special Working Party has been established in this regard by the Euratom Treaty Article 31 Group of Experts. The Group approved some recommendations regarding remedial actions for existing buildings and preventive actions -at the design level- for future buildings. These recommendations are under the consideration of the appropriate legal service of the Commission (EUR 11917 EN). Maybe in this case some EC regulatory action will come out from EC funded or coordinated research.

4.7. **Some reflections.**

The problems addressed and the "histories" of the regulatory actions examined in the previous paragraphs are so different that almost no common features appear to be traceable. It is then worthwhile to suggest some reflections regarding the main points emerging from our six cases.

a. Uncertainty and uncertainty management.
Scientific uncertainties are present in all the cases analyzed. Their degree may change, some of them may be overcome with some more time and research while other seem to challenge any research effort. But they always accompany at least some stages of the regulatory process where research inputs are required.

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The management of uncertainties may differ along five main lines: ignore them, use them to block, to delay or to urge decisions or to legitimate different kinds of decisions. In many cases (limit and guide values of SO 2, biotechnology regulatory options, CFCs reduction percentages and timing) scientific uncertainties were or are used to legitimate different decisions. When uncertainties regard the causes more than the effects of a given phenomenon they can be used to block decisions -as the beginnings of the acid rain issue demonstrate- because it may be argued that no action can be taken without knowing exactly about what. On the other hand, when the uncertainties regard the scale or timing of the effects of a given product or technology they can be used to postpone -or to urge- decisions: CFCs damage the ozone layer but maybe there is still time -or maybe it is already too late- before their effects become catastrophical, then it is possible to postpone -or it is necessary to urge- their ban; radon (and all the other radioactive substances) is dangerous for health but maybe the effects of exposure to radon in indoor environments are not so serious, therefore design precautions can be postponed. Uncertainties may then be used to select information in the "preferred" way, by arguing that the available information is sufficient or insufficient to take certain actions or to take -or not to take- action at all. One of the possible action being the regulation of research itself, as in the case of biotechnology.

What appears to be crucial is the balance between the seriousness (degree) of uncertainties and the seriousness (scale, reversibility, etc.) of the phenomena under consideration. In face of possible catastrophical events, uncertainties regarding the scale or timing of certainly harmful consequences are relevant for the adoption of well-aimed countermeasures, but they are not relevant for deciding whether to take or not at least provisional precautionary measures. On the other hand, deep uncertainties concerning the actual management of

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a technological system or the actual behaviour in the open environment of substances and organisms analyzed within laboratories' walls should be considered as important elements for both risk assessment studies (actual risk management procedures influence, for instance, the probability of occurrence of accidents and the quality and size of their consequences) and for policy decisions.
Sometimes what seems to be "rational" from an abstractly logical point of view - i.e. based on a scientific knowledge regarded as objective and indisputable- may reveal to be not "reasonable" from a pragmatical -not less logical- perspective where various scientific, political, economic and social elements (and uncertainties) are taken into account.

b. The national, the EC and the broader international context.
Many factors may influence the different management of uncertainties: political attitudes (as in the case of the definition of "dangerous for the environment" and the one of the approval of the Directive on SO 2 limit and guide values), ethical concerns (as in the case of animal welfare and some applications of biotechnology), economic interests (for instance, in the case of CFCs use reduction or ban and again in the acid rain issue, and also -together with political and ethical attitudes- in the case of biotechnology).
In turn the weight of these factors may differ depending on their context. All the history of the acid rain issue (from the initial controversies between Scandinavian states and UK and FRG, to the adoption of the Directive on SO 2 values, to the changed attitude of the FRG after the emerging of the "Waldsterben" phenomenon), the increasing national and EC attention towards the problem of ozone layer depletion following US and UN initiatives, and the emerging of biotechnology development and regulation as an EC issue after the initiatives of some member States on the one

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hand and of the US on the other hand, show that the relative weight of political and economic factors may change because of international or national pressure and conditions.

The EC institutional context is a very peculiar one, being a sort of "bridge" between the domestic sphere of its twelve member states and the global international context. A bridge the shape of which is influenced on the one hand by the national (as defined by their governments) interests of member states, and especially of the most -economically and politically- powerful members, and on the other hand by the actions taken by non-EC "leading countries" (mainly US) and by international organizations like OECD and UN.

A specific purpose of the EC is "to speak with one voice" in the international fora and regarding transboundary issues, and this implies that an agreement/compromise between the EC member states has first to be found. To facilitate the achievement of an EC common position and overcome intergovernmental conflicts, it has been decided to introduce -for some decisions- the majority rule instead of the unanimity one: in this way the possibility that some decisions are blocked because of the veto of few states can be overcome and the EC institutions (particularly the EC Commission) may have more authority both at the Community and at the broader international level. A category of decisions for which the majority rule is applicable is the one regarding the harmonization of measures necessary to establish the Internal Market (Single European Act, art. 100 A), among them many environmental regulatory actions.

It seems than that a specific EC role in setting environmental disputes is emerging. But which EC attitude/position towards environmental problems will develop in the near future depends very much on how environmental considerations are taken into account in the process of completion of the Internal Market.

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EC environmental policy (and research) is in fact the result of its political, economic and social environment.

c. The utilization of EC and/or external environmental research for EC environmental policy.

In some cases (for instance, the one of ozone layer depletion), EC funded or coordinated environmental research played no role and the scientific basis for regulatory action was more or less "imported" from US or from research institutes of EC member states working autonomously (like the British Antartic Survey). In other cases, EC funded or coordinated research on a specific topic started after the growing of research in some EC or other European countries (as in the case of research on acid rain), but its utilization does not appear to be optimal partially because of the lack of policy-oriented analysis. In one of the examined cases - indoor pollution - EC direct and coordinated research is providing a possible input for future regulatory measures.

These differences depend on the available economic and scientific resources at the national and at the EC level, and on the previously discussed science-relevant policy pursued by the Community before and after the adoption of the first Environmental Research Programme. It is certainly not a chance that research on radon -a radioactive gas- is quite advanced at the EC level, given the former almost exclusively nuclear orientation of research efforts. While it is not surprising that research directly related to the ozone layer phenomenon started only in 1989, at least if one notes that the climatology programme was started in 1980 with a budget of only 8 million ECU and that the availability of technological resources (for instance, satellites for stratospheric ozone measurements) depends on the readiness of organisms (like the European Space Agency) not directly related to the units of the Commission responsible for environmental research.

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A good reason (aside from elements of prestige and political or economic competitiveness) for starting a specifically EC research on fields regarding global problems, even if there are already other international or national organizations conducting studies on such problems, is that global phenomena like ozone layer depletion and global warming may involve different consequences in different parts of the world depending not only on natural but also on social and economic conditions.

Here again the importance of linking social and natural sciences emerges, in spite of its underestimation within EC research policy. And if it is important to promote and coordinate research in natural sciences at the European level, it seems at least equally important (or even more necessary given their more limited possibility of generalization) to develop European social studies.

This is not only a matter of culture but a matter of politics. In fact, if it is recognized that there is an influence of testing methods -and changes in testing methods- on regulatory practices, it should be also recognized -and made explicit- that assumptions on risk acceptability or on trade-offs between different interests and values are inherent features of decision processes. In this respect, research efforts aimed at enlightening the social (beside the technical and scientific) components and consequences of regulatory actions (for instance, social acceptability of high risk technologies, risk management problems, adequacy or inadequacy of cost-benfit analysis to deal with distributive and other political issues) could be useful in order to improve the informative basis needed for decisions, and also to make such decisions more "transparent". Which is a necessary condition to make them also more open to public scrutiny and participation, as they always should be in really democratic political systems.

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d. The time dimension.
Different time perspectives cross each other in dealing with environmental issues: the time of nature cycles, the time of policy actors (elected officials, economic interest and public interest representatives, administrators), and the time needed for research.
Sometimes the long time needed by researchers to obtain sound/accepted results is a serious problem for policy makers who need a reliable scientific basis to decide on regulatory actions, while sometimes it is taken as an excuse by some policy actors to postpone undesired decisions. The word "excuse" is used because in cases like the one of CFCs, also partial, uncertain results had be sufficient to take provisional, precautionary actions.
Short-term economic and political (for instance, electoral) gains are sometimes in conflict with long-term perspectives where reparation and prevention of natural (and not only natural) damages is taken into account.
The problem in this "time game" between nature, science and politics is that even if it is very difficult to abolish aerosol or to find different sorts of refrigerators, it is certainly impossible (at least for humans) to live without the protection of ozone layer against ultraviolet radiations.
Again different models of rationality face each other: what is -or appears to be- rational in the short-term for economically or politically self-interested individuals, may turn out to be myopic and counterproductive in the long-term and for the whole society.

e. The interplay between knowledge and discretion underlies all the above mentioned points.
How to deal with scientific uncertainties, how to balance economic, political, etical, scientific and environmental factors at the national, the EC and the international level, which scientific (and other) resources to utilize, how to interpret

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scientific results and legislative provisions, how to take into account the time dimension, are all questions where the interplay between knowledge and discretion is at the core of decisions. Knowledge and discretion interact in the process of problems and hazards identification (the potential or verified damages due to SO 2, CFCs, radon and biotechnology products being cases in point), in the assessment of risks (including the uncertainties connected with actual risk management) and in the evaluation of regulatory options (ban or limit the use and production of certain substances, set standards or take other measures). The multi-level negotiatios peculiar of the EC contect make this interaction sometimes more and sometimes less visible, but it is always at work.

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5. IMPROVING THE LINKS BETWEEN ENVIRONMENTAL RESEARCH AND ENVIRONMENTAL POLICY.

Paraphrasing the frequently paraphrased sentence of Kant[13], one can say that environmental policy without environmental research is blind and environmental research without environmental policy is empty, or better it is useless for coping with environmental problems.

The need to connect research and action is explicitly recognized in the written programmes examined in the third chapter, and certainly knowledge -filtered through political and administrative discretion- took part in the formulation of the regulatory measures analyzed in the fourth chapter.

But these theoretical (written programmes) and practical (in actual regulation) links between environmental policy and research run the risk of remaining good intentions only applied in a piecemal way (depending on favourable conditions or personal willingness), if they are not also institutional links, that is links provided by institutional procedures and organisms.

Institutions are social - not mathematical or logical - constructions and their functioning do not necessarily guarantee efficient connections between goals (in this context, find measures to face environmental problems) and tools (among them, the proper utilization of research). However, given the fact that both policy and research are performed within institutions (

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13. "Thoughts without contents are empty, intuitions without concepts are blind" , The Critique of Pure Reason, Introduction to the Second Part.

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political, economic, scientific institutions), it seems reasonable to stress the importance of institutional links between them.

Coordination, evaluation and control are the three main functions which should be performed by specifically established organisms and according to explicitly defined procedures, in order to improve the links between knowledge and action in the environmental field. It goes without saying that political judgments and administrative discretion have a crucial role in building these links: evaluation and social control are by definition non-neutral activities (their tools can maybe be "objective" but their assumptions are not), and also coordination of data and functions is not a purely technical matter.

In the Community these functions are taken into account and are being performed in the environmental field for some years. But some improvement seems to be necessary.

Without any pretence to offer recipes and solutions, the following analysis may perhaps help in focusing problems.

5.1. Coordination: CORINE and the Inter-Services Working Groups.

Two different kinds of coordination shall be distinguished: coordination of data and coordination of functions.

Coordination of data in the environmental field is currently performed within the **CORINE** programme. Corine (COoRdination of INformation on the Environment) is an experimental programme for gathering, coordinating and ensuring the consistency of information on the state of the environment and natural resources in the Community. The programme is attached to DG XI and started its activities in 1985 following a Council Decision (O.J. L 176, 6.7.85) that emphasized the need to improve the availability, comparability and consistency of data, and established three main

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areas of application: biotopes of major importance for nature conservation in the Community, acid deposition and emissions into the air, protection of the environment in the Mediterranean Region. The Scientific and Technical Secretariat of Corine organized its work within two broad areas: the development of procedures for the collection, standardization and exchange of data in the Community, and the establishment of a Geographical Information System (GIS) capable of providing policy-related information on the Community environment.

The implementation of these tasks has proven to be quite difficult because of the little room for manoeuvre between the specific demands of users (particularly the Commission's services) who want speedy and detailed information and the insistence of scientists that priority be given to establishing the foundations of the information system. In fact the attempt to satisfy users' demand could lead to inconsistent results, while the attempt to keep to scientific criteria could considerably delay the provision of usable results. It has not always been possible to reconcile these two constraints, therefore sometimes it has been decided not to seek quick but unreliable results, or -conversely- to postpone the collection of more detailed data or the establishment of more sophisticated methods which would have provoked unacceptable delays in the provision of basic information in priority areas (EC Commission, COM (88) 420 final). Moreover the enormous variation between countries and regions in the availability and quality of data made necessary to adopt specific projects to start the collection of data in member states where it was lacking: such a national collection was a necessary pre-condition to the work of coordination and systematization of data at Community level. But also when data are collected, member states or other data holders (like industry, professional organizations and local administrations) are not always willing to make them available, therefore the CORINE team had also to cope with the problem of

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confidentiality of information and sometimes had to use its authority as operative unit of the Commission to obtain data. In spite of all these difficulties, by June 1989 -when the experimental period of CORINE ended- an impressive data base has been developed, which covers various elements related to the three priority areas selected by the Decision establishing the programme. Besides this, the activities conducted within CORINE produced an improvement in the networking between the Commission, the member states, the regions, various scientific organizations and data holders, and international organizations in the field of data gathering and coordination.

Some ad-hoc, temporary groups formed by officials of various Directorates General of the Commission have been established to coordinate or at least join efforts on specific issues. The word "coordinate" is in fact not always suited to indicate the activities conducted within the **Inter-Service Working Groups** which are sometimes more a forum for discussion than coordinating units. Depending on the task established and the kind of activities performed, the Inter-Service Working Groups may produce different outcomes: providing background information on a specific issue of common interest (for instance, the Communication of the Commission on " The Greenhouse Effect and the Community ") or suggesting policy actions (like the two proposed Directives on biotechnology regulation).
But this ad-hoc, case-by-case approach seems inadequate to guarantee coordination between regulatory and research functions in the environmental field. Effective coordination would in fact require a continuous and sistematic assessment of the research needed for regulatory purposes on the one hand, and -on the other hand- of the environmental trends and threats discovered through research.

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A step towards more effective coordination was made in July 1989 when it was decided that an official of DG XI would act as a coordinator between the activities of DG XI and those of DG XII and of the JRC, taking also into account other Community research activities related to the environmental field: mainly the researches conducted within other DGs (for instance, the programme Joule on alternative energies within DG XVII, the programme DRIVE on pollution due to the traffic within DG XIII, the programme ECLAIRE on pesticides within DG VI) and the R & D programme financed by industry (like EUREKA which includes a programme, EUROTRAK, on stratospheric chemistry). But the size of the work and the need of implementing a not "unilateral" coordination seems to require a unit more than a single person. In fact DG XI cannot but ask pre-normative research (that is "state of the art" reports or short-term laboratory or field experiments and measurements) which is needed for the formulation, modification or improved implementation of regulatory actions. Other DGs could be interested (if integration of the environmental dimension in other EC policy domains is taken into account) in introducing "environmentally friendly" technologies and products in their promotion activities: and both DG XI (through the ACE project which allows the funding of clean technology demonstration projects up to 30 %) and DG XII and the JRC (which are funding or conducting research on clean technologies) are reference points in this regard. Finally, researchers should communicate to policy makers the environmental trends discovered through their studies and observations, in this way providing a basis for possible future regulatory (and promotion) actions.

In short, coordination between policy and research in the environmental field should involve three distinct but connected elements: coordination of activities for short-term regulatory purposes (science <-> regulatory policy); coordination of

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activities for policy -non regulatory- activities like industry promotion (science <-> non-regulatory policy); coordination of activities for possible long-term actions (basic research <-> long-term policy).

5.2. Evaluating scientific research in the environmental field.

Evaluation of scientific research in the Community is aimed at providing the Commission with information and advice that may be useful in order to decide whether to start, continue, modify or stop the research programmes under examination. Evaluations are performed by internal and external bodies and cover various aspects concerning the selection and implementation of research programmes (usually cost-shared programmes).
Internal evaluations are the responsibility of the programme managers of the Commission - DG XII - in consultation with various advisory committees[14], the interested parties in the member states and the Evaluation Unit within DG XII that is also required to arrange external assessments. Such internal evaluations are aimed at ensuring that the rationale for Community funding and the key points of each research programme are defined before it is submitted to the Council for approval. Moreover, internal

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14. The main advisory committes are the followings: the JRC Scientific Council and the JRC Board of Governors (which is however quite different from the other advisory committees), CAN (Committees of Advisory Nature, previously called CGCs - Management and Coordination Committees), CODEST (Committee for the European Development of Science and Technology), COMACs (Concerted Action Committee), CREST (Scientific and Technical Research Committee), CST (Euratom Scientific and Technical Committee), IRDAC (Industrial Research and Development Advisory Committee), and other committees attached to specific programmes like CCPF (Fusion Programme Consultative Committee), EMC (ESPRIT Management Committee) and RMC (RACE Management Committee).

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evaluations should also guarantee that the information and data needed (for instance, on the criteria used for appraisal and selection of project proposals, on the procedures for their authorization, etc.) for all subsequent external evaluations are collected from the beginning of the programme (COM (86) 660 final).

External evaluations are performed by panels of external independent experts, formed by specialists in the relevant technical field and from different fields, users of the results, experts with managerial and economic background, science policy experts. These panels may be asked to evaluate the scientific and technical achievements of the programmes, the contribution of such programmes to the development of European science and technology, their contribution to other Community policies, their management and also their social and economic impact. That is, external experts are asked to perform ex-post evaluation about the implementation of the programmes, not to give their opinion on the selection procedures, even if they can include this point "indirectly" in the evaluation of programmes' management and in the final recommendations.

Evaluation methodologies are still in progress (R. Chabbal, 1988) and in order to improve them the Commission drew up a Community programme (COM (88) 386 final) in the field of strategic analysis, forecasting and evaluation in matters of research and technology -MONITOR- formed by three distinct but connected activities: strategic and impact analysis (SAST), forecasting (FAST) and research to improve methodologies and effectiveness of research evaluation (SPEAR).

In the meantime (that is, before the results of these efforts become available) serious difficulties remain in the evaluation of each of the five mentioned aspects that experts' panels are asked to evaluate.

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Bibliometric studies and peer reviews are often used to assess the **scientific quality and achievement** of the research programmes: but on the one hand, extra-scientific conditions may influence, for instance, the access to scientific journals or the diffusion of a study; and on the other hand the use of bibliometric studies may give a distorted picture when the research conducted is mainly applied research.

Also the contribution of EC funded research to the **development of european science** is not a very easy matter for evaluation. But quantitative and qualitative assessments of contracts and collaboration between research institutions of different countries can provide at least some indication about the improvements in the development of scientific networks in the Community.

Regarding the **management of research,** what has to be judged is whether the programme fulfilled its objectives given the budgetary (and personnel) constraints. But in the case of cost-shared research, the Commission finances only part of the programmes and then contributes only partially to the definition and the achievement of programmes' objectives. When the problem of research management improvement is at stake, usually two suggestions are given: restrict the area(s) of research, or increase money and personnel. The second suggestion implies decisions on resources allocation and priority definition; the first one involves considerations concerning the selection of research topics and about the possibility that the restriction of research areas can make them more manageable, but at the expense of new interesting topics or aspects of research.

Evaluating the **socio-economic impact** of research programmes is the most difficult step. Socio-economic impacts of research depend on a variety of complex elements like the diffusion of research results (especially in terms of technological outputs) at the national and international level and among different sectors of society, their specific or pervasive nature (information

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technologies being a case in point), their centralized or decentralized management, and other elements. Moreover socio-economic impacts of research may be indirect and long-term ones which make their evaluation even more difficult. But still necessary given the increasingly fast scientific and technological developments which characterize "post-industrial" societies.
The **contribution of the research programmes to other Community policies** is a crucial element with respect to the utilization of knowledge for policy making. This element has been addressed in the previous chapters with respect to environmental field, and it is dealt with -together with the evaluation of the other above mentioned aspects- in two Evaluation Reports on the R & D programmes in the environmental field.

The first Evaluation Report on Community's environmental research programme - prepared by a panel of seven experts chaired by G. Fuelgraff, former President of the Bundesgesundheitsamt of the FRG - covers the period 1976-83 (EC Commission, 1986).
In its overall appraisal the panel states that -with special reference to the third ERP- " Almost all projects satisfy high quality standards and they are generally well related to the practically relevant problems. Often they provide the answers needed for political decisions and actions, and any reluctance to move into such action has other reasons than lack of knowledge or of an adequate scientific basis" (p.191). This statement may sound very optimistic (also in the light of the previous analysis of some Directives) about the power of science to provide "answers needed for policy decisions". But one can argue that these not better specified answers are not necessarily certain ones: on the contrary, answers which are uncertain as far as their scientific content is concerned, may be however useful for policy decisions. Anyway the quite explicit target of the quoted

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statement is the instrumental resort to cognitive reasons to cover political ones.
The return of research in terms of technical help and support to environmental policy is also considered very high in view of the relatively small resources which are invested in EC environmental research (p.191) and of other management problems like the rather complicated, rigid and time-consuming Commission's internal rules for the approval of the JRC programmes (p. 17) and for research contract management (p. XIV), with the connected long-time delays between proposal submission and contract letting (p. XVII). Moreover it is pointed out that scientific and political needs may change over time and then it should be possible to adapt the multi-year programme to meet these changing needs and to redistribute the allocation of funds to the various research areas. In this respect a rolling-system is suggested to allow flexibility by reviewing annually the four or five-year programmes, which are anyway to be kept in order to maintain steadiness (p.193).
It is also recommended to integrate more closely direct, indirect and concerted actions (p.192) and to shift the focus of research from measurement, sources and effects of pollutants to such areas as pollution prevention and abatement and impact assessment (p.197). The panel also notes that few projects had direct policy component and recommend to pay more attention to policy studies (p. 69) and to the development of economic, social and behavioural science research as an integral part of the programme (p. 197).

In the very first page of the second Evaluation Report of R & D programmes in the environmental field (EC Commission, 1988) it is pointed out that this last recommendation has not been implemented within the Environmental Research Programmes.
This second report - prepared by a panel of five experts chaired by J. Dooge, President of the Royal Irish Academy - also

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emphasizes that, while the effectiveness of the programmes has increased as the result of some changes in line with other previous recommendation (for instance, the breaking down of the rigid separation between contract research and concerted action), more efficient communication linkages should be established with other Directorates General by replacing sporadic with systematic communication (p.27).
Besides specific evaluations and recommendations regarding the scientific content of the research programmes, the panel also suggests to introduce an assessment of the input of research to Directives and to EC environmental policy more in general, and to interpret the results of scientific research in terms of its economic, social and political implications (p.25).
Maybe in a future third Evaluation Report it will be possible to know whether these recommendations have been taken into account.

5.3. The control of science and technology.

" Democracy versus Guardianship " is the subtitle of a book of Robert Dahl (Dahl, 1985) where the author examines in a contemporary perspective the theory of guardianship advanced by Plato in "The Republic". The starting point of Dahl's analysis is the question : are contemporary democratic institutions able to face the complexity of public policy issues or would it be better to delegate decisions to experts (technocrats) ? The "conditional" answer of the author is that democracy might be suited to cope with complex issues if citizens are competent both from a moral and an instrumental (technical) point of view, if they are able to control the decision making process and if elected representatives pursue the goals set by the majority of citizens.
Dorothy Nelkin frames the same problem in a different way by stating that technical expertise itself is not a neutral matter

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and that public controversies on science and technology issues reveal that such issues are political ones involving the crucial question of social acceptability and social control of technologies (Nelkin, 1979).
From a normative point of view, David Collingridge argues for a social control of technology (Collingridge, 1980) and for the avoidance of rigid technologies which escape such control and require instead that society adapt to their imperatives (Collingridge, 1985).

These problems are partially echoed in the Resolution of the European Parliament (O.J. 288, 11.11.85) establishing, on suggestion of MEP Roelants du Vivier, the Office for Scientific and Technological Option Assessment (STOA):
" a. whereas science and technology are playing an increasingly important role in society.
b. whereas scientific and technological projects are becoming not only more costly but also more complex, which means that their consequences are not always foreseable.
c. whereas democratically elected parliaments have the responsibility and authority to determine the direction in which society should develop.
(...) 1. Considers that it is becoming increasingly important for the European Parliament to be able to assess and influence the effects of technological projects (...)."
The explicit reference point for constituting STOA is the Office of Technology Assessment (OTA) of the US Congress, established in 1972 with the task of providing decision-makers with sistematic and global assessment of the implications of various technology options. Moreover, before the adoption of the mentioned Parliamentary resolution, similar initiatives had been taken in some EC countries like the Office parlamentaire d'evaluation des

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choix scientifique et technologiques in France, the Enquete-Kommission fuer Technologiefolgenabschaetzung in the FRG, the Netherlands Organization for Technology Assessment.
One of the reason for having STOA within the European Parliament is the need to escape a vicious circle in which the parliamentary rapporteur criticizing a Commission proposal was forced to seek help in his/her task from the very Commission services responsible for the proposal (STOA, 1988). This does not prevent STOA from having fruitful contacts with Commission services (for instance, with the evaluation unit within DG XII), but requires the resort to external sources. These sources are not only outside the Commission, but also outside the Parliament. STOA is in fact formed by a supervisory panel of four Members of the European Parliament and by a project team of only six people (a very small staff in comparison with over two hundred people working within OTA), therefore STOA cannot conduct but only commission and supervise the assessments and the diffusion of results.
Given this situation, one may wonder what is the difference between the activities conducted by the panels of external experts organized by DG XII and the ones conducted by the external experts working for STOA. One difference regards the task: the panels arranged by DG XII evaluate EC existing research programmes, not the consequences of different possible technology options; moreover STOA is a kind of "service" for Member of the Parliament who need some background information on specific issues to be discussed by the Parliament. The other difference could be the " degree of independence ": but in case the panels of external independent experts arranged by the Commission are considered not really independent, that should be spelled out and consequent action should be taken. If this is not the case, it could be maybe possible to join efforts between STOA and DG XII Evaluation Unit to organize and utilize the work of such panels.

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Regarding the relevance of environmental issue in STOA's activities, it shall be mentioned that three topics have been investigated in the first eighteen months of STOA: 1. EC research on controlled thermonuclear fusion, 2. reorganization of telecommunications in Europe, 3. trans-frontier chemical pollution. And other three topics were chosen for 1989: 1. food (hygiene standards, labelling, etc.), 2. waste (particularly hazardous chemical waste), 3. remote sensing (to assess its possible utilization for environmental, agricultural and other EC policies). It is easy to see that environmental issues are directly or indirectly (one of the point of the STOA project on fusion concerned the assessment of possible environmental impact of such technology) addressed by most of the chosen assessment projects.
But this ad-hoc, piecemal approach -appropriate for an experimental phase- cannot provide any sistematic technology assessment with regard to the environmental field or to other ones. Good will is unfortunately not enough to guarantee the provision of basic and pluralistic information needed for a democratic control (at least in the quite restrict sense of parliamentary control at the EC level) of technology.

Environmental non governmental organizations (NGOs) are important actors in the debate on the social control of technology.
In many countries such organizations had/have a main role in the controversies on nuclear power, biotechnology and other science and technology issues. At the European level, the environmental NGOs grouped in the European Environmental Bureau (EEB) are becoming more and more interested in the utilization and impact of science and technology, and in the need of some forms of public participation and scrutiny in deciding about scientific and technological options in the environmental area. Therefore the

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EEB -together with the Standing Conference of Rectors of the European Universities (CRE)- organized a seminar on "Research and Environment" (held in May 1989) to debate these issues at the substantive and methodological level and the proposal was made to establish within the office of the President of the EC Commission an advisory board formed by NGOs and CRE. This may be a step in the direction of public involvement in EC decisions on research and environment. But a lot remains to be done on crucial issues like the freedom of information on data and projects related to the environment (a Directive has been proposed on this matter) and the implementation of forms of public participation, for example within impact assessment procedures.

5.4. Towards an European Environmental Agency.

" Dulcis in fundo " an important proposal announced personally by the President of the Commission Jaques Delors in January 1989 is enriching the complex development of links between environmental policy and environmental research at the Community level.
In his speech to the European Parliament on the 16th of January 1989, Delors spoke of the setting up of a European environmental measurement and information system involving regional or national, public or private facilities as part of a Community network. In a following proposal of the Commission (COM (89) 303 final) for a Council **Regulation** on this matter, it is stated that nodal point of such a **European Environment Monitoring and Information Network** (EEMIN) shall be a **European Environmental Agency (EEA)** having the role of coordinating the network and of ensuring the coherence and consistency of the information supplied through the network. The EEA should be given legal autonomy while maintaining a close institutional relationship to the Commission, and it should be financed through a new budget line within the Commission and through contributions of participating states. It should have an

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Executive-Director and a Management Board consisting of one representative of each member state and two representatives of the Commission plus two scientific personalities designated by the European Parliament. A Scientific Committee made up of six members should assist the Executive-Director and the Management Board in drafting the annual programme of the Agency (which must be then approved by the Commission) and in any scientific matter concerning the Agency's activity which the Director or the Board may submit to it.

Moreover, given the trasboundary dimension of many environmental problems, the EEA should be open to the participation of third countries.

Task of the "system" including the network and the agency should be the following ones: 1. to provide the Community, the single Member States and participating third countries with the objective information required for the formulation and implementation of sound and effective environmental policies; 2. to provide technical, scientific and economic information requested by the Commission in its task of identification, preparation and assessment of the implementation and results of environmental action and legislation; 3. to stimulate the development and the application within the Agency of techniques of environmental modelling and forecasting in order that adequate preventive action can be taken at the appropriate time; 4. to help ensure the harmonization and comparability of environmental data in the Community as well as the integration of European environmental data into international environmental monitoring programmes; 5. other tasks as may be defined by the Management Board in agreement with the Commission.

In the proposal it is also stressed that the system should furnish information which will be directly usable in the implementation of Community environmental policy, and that it should take into account economic questions.

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An important criterion stated in the Explanatory Memorandum is that the Agency should operate as far as possible by building on the existing environmental networks and institutions, at the national, EC and international level. At the national level, member states are required to indicate to the Agency the main component elements of their national monitoring networks; at the Community level cooperation should be sought between the Agency and Community bodies and programmes like the JRC, the Statistical Office and the Community Research Programmes, and the Agency should be entrusted with continuing the work undertaken by the CORINE programme; at the broader international level, the Agency should cooperate with bodies like the European Space Agency, OECD, the Council of Europe, the UN and particularly UNEP, the International Atomic Energy Authority and the International Energy Agency.

Having described in some detail the contents of the proposed Regulation, some remarks can be made taking into account the three elements discussed in the previous paragraphs, that is coordination, evaluation and control.

Coordination. As it is clearly indicated in the proposal, coordination in the field of environmental monitoring and data gathering, harmonization and diffusion is the main function of the EEA. Therefore it is not surprising that the suggestion is made to entrust the Agency with the continuation of the work undertaken within the CORINE programme: as a matter of fact CORINE represents the basis of the new Agency, both at the conceptual level (CORINE was established precisely in order to gather, coordinate and harmonize information on the environment in the Community) and at the practical one (by means of the already established data bank and networking activities). The problem in putting the activities performed by CORINE in an organism outside the Commission may be constituted by the "purely voluntary basis" of the cooperation between the Agency and the different elements of

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the network (point 6 of the Explanatory Memorandum). As it was previously remarked, data holders are not always willing to make their data available and this could constitute a problem not completely solvable through the attribution to the Agency of legal personality at the Community and at the national level (article 4). On the other hand, the involvement of third countries in the Agency - which represent an important recognition of the necessity to coordinate monitoring and information activities at a broad international level - is facilitated by the special legal status of the EEA.

Evaluation. The drafting of the annual work programme and of the reports of activities of the Agency involves some kind of evaluation procedures about the quality, management and usefulness of the work done and about the reasons for starting, continuing, modifying or suspending certain activities. In the proposal it is not specified who should conduct these evaluations, and the problem arise regarding whether it would be better to commission evaluations to external independent panels of experts (as in the case of EC research programmes) or to the Scientific Committee of the Agency.

Control. The Agency is financially and politically controlled by the Commission that decides about the budget allocation and has the power of approving -or not- the annual work programme of the Agency. The European Parliament is given the honorary tasks of debating the annual report of the Agency and of designating two scientific personalities to be included in the EEA's Management Board. While it is stressed that the Agency shall ensure the wide diffusion of reliable environmental data (article 4), it is not formally specified how shall be guaranteed that the information gathered will be actually disclosed to the public.

Finally, one is tempted to make a comparison between the EEA and the US Environmental Protection Agency (EPA), and it emerges

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immediately that the **coordinating** role envisaged for the EEA is much more limited than the **regulatory** role of the EPA.
The EPA has the tasks of proposing national ambient quality standards, set emission levels, approve implementation plans that prescribe specific emission limitations, promulgate effluent guidelines that designate allowable discarges for various industrial categories and issue permits to individual manufacturers that would achieve the best practicable technology in the time allowed (in J.Q. Wilson, 1980: p.274). The EEA has instead tasks aimed at providing the informative-scientific basis for allowing the Commission and the competent authorities of the participating states to perform regulatory functions.
This is due to the general differences between the US and the EC context, that is the differences that exist between a federal State and a supra-national, or inter-governmental, entity. Even more, they depend on the fact that a regulatory role is performed -at the Community level- by some Directorates-General within the Commission (particularly by DG XI as far as environment protection, nuclear safety and civil protection are concerned) and on the impossibility -accoding to the existing Community law- to move regulatory competences outside the Commission.
The result of the comparison is therefore that the equivalent of the EPA at the Community level -as far as the competence to establish regulatory actions is concerned- is not the EEA but DG XI; with the important difference that the US Agency has also direct responsability for the implementation of regulations, while in the Community context the authorities which are directly responsible for implementation are the ones of the member states, under the supervision of the EC Commission that can bring cases of (persistent) non-compliance before the European Court of Justice. The European Environmental Agency shall act instead - as it was stated by the Commissioner for the Environment M. Ripa di Meana (Information Memo, EC Commission, 21 June 1989) - as the "

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bras scientifique et technique " of the Community, at least in the sense of providing (not producing) the scientific information useful for regulatory purposes.
This means that the EEA -as it is proposed by the Commission- shall not be regarded as a centralized institution for the formulation and implementation of environmental regulation at the Community level but as an important tool for improving the links between environmental policy and research.

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Opening Conclusion.

Things are developing very quickly in the Community. Many changes occurred since I started working on the subject of this study, and many changes will certainly occur in the near future which will make some parts of this paper out-of-date very soon.
This is the risk that one runs in analyzing processes and events in progress. But this is also one of the most fascinating aspects of the endeavour.
What seems to be a quite easy forecast that can be suggested in these not concluding remarks, is that an increase in international cooperation will be required by the worsening of global environmental threats. The Community is already taking a very active role in this necessary internationalization of environmental policy, information and research. And while collaboration between industrialized and developing countries is becoming crucial, the first ones -including EC member states- should be particularly active in strenghtening the measures aimed at protecting the environment both because they are the main responsible for environmental degradation and because they have the resources to take action. Action which may be decisive for the future.
In the words of Lester Brown and Edward Wolf of the Worldwatch Institute (1988), " We are left with the sobering realization that our generation is the first whose decisions will determine whether the earth will remain habitable ".

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