Pergamon

Progress in Oceanography 44 (1999) 433–456

Progress in Oceanography

Interactions between research and policy. From wishes to realities, in a changing world

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Abstract

The purpose of this paper is to make a point on the question of the links and interfaces that exist (or should exist) between research and policy in a field where these interactions are specially strong and multifaceted. Attention will be paid to what these entities have in common and where they are either different, or convergent, or divergent in their logic and dynamics, knowing that they are linked in many ways, both directly and via other systems.

This discussion will be supported largely by an analysis of the mechanisms of the structural changes of economic systems through 'long term crises' mechanisms in developed countries, as well as by a discussion on the roles of 'value allocation' processes in post-industrial societies. These determine essential matter of the orientation of the 'policies' particularly in decision-making for which one never knows if they are decided by some inspired personalities, or if they only arise in terms of actions, as responses to current problems.

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0079-6611/99/$ - see front matter
PII: S0079-6611(99)00038-5

1. Introduction: the identification of the actors

The co-sponsorship of scientific programmes and events by research institutions and local and regional political authorities is becoming progressively more usual. However, this approach soon encounters serious contradictions that the 'research policies' have to overcome and manage. These contradictions arise because the different sponsors prioritise their objectives for the themes of the programmes with contrasting ranking. The objectives are prioritised by research institutions in the order of scientific, economic, sociological and political; whereas political authorities prioritise them in the reverse order. Herein lie the seeds of conflict. Agreements between the actors on what the objectives should be, may be seen as being reassuring, but their mutual inversion of the hierarchy of their prioritisation of the objectives casts very different, and often conflicting, perspectives on their interactions.

One notes that 'science' and 'policy' objectives appear at opposite ends of the rankings as areas where the 'sense' of the activities are mainly endogenous for science, but exogenous for the development of policy. However, now it is impossible for science to be conceived without the mutual interaction between these two conceptual approaches; without a basis of endogenous objectives, involving the need to do good, innovative science, there will be no motivation for the researchers. But without the exogenous objectives, which seek to serve the broader needs of society, there will be no external support, and hence no financing of the programme. In reality such conflicts only become a problem when the objectives diverge, and fortunately this is not always the case.

Thus, I introduce the actors in the interplay; they are those who define the aims of the research (policy- and decision-makers), those who manage its realisation (administrators) and those who undertake it (scientists). There are also those who await the results; these are either the paymasters or those who hope to gain some benefit from the research (citizens and others involved in the economy). Thus there are not just two arenas of interaction but four to consider, even if there is extensive

overlap between these arenas (Fig. 1). Moreover the interactions are large, particularly as all the actors (decision-makers, administrators and researchers) are amongst the citizens who are expecting some benefit either in the short- or the long-term to accrue from the research.

Thus in our reflections on the interactions between research and policy, we must remember that they are neither homogeneous nor unchanging, because this would implicitly mean that:

- Current research policies provide the full and complete expression of what society (the citizens) wants or needs, that the research programmes correctly translate these aims, and that the researchers are totally successful in interpreting the objectives of the research programmes.
- Changes in the deep structural, functional, material and cultural requirements that always follow from the development and evolution of needs and wishes of the actors can be ignored.
- Research is immutable in its structures and functioning, and does not change either because of its own internal conceptual development or as a result of evolving social demands.
- The new organisation levels in programming, co-ordination and financing of research that have developed over the last few decades at regional, national and supranational levels can be ignored. Up until the 1960s the majority of science was developed and programmed at the national level, whereas now internationally co-ordinated programmes are playing an increasingly important role.

Our analyses of the evolving social contexts and research environments which follow will therefore address the following themes:

- The identification of the theory and endogenous influences that determine the conceptual framework, planning and pursuit of the research adopted by each entity.

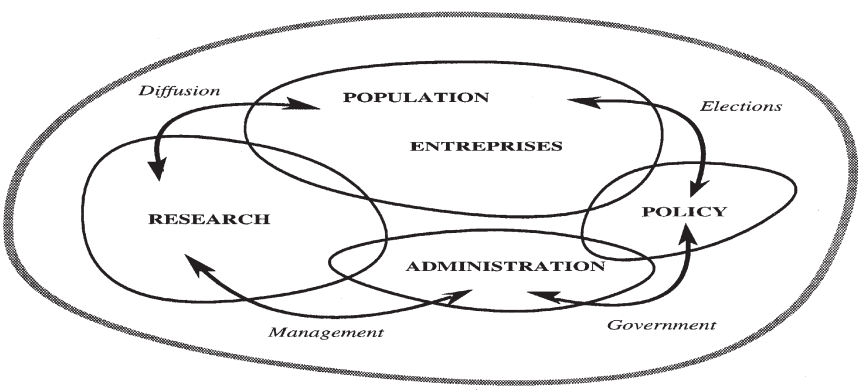

Fig. 1. Interactions around research.

- A discussion of the recent trends in the theory and driving forces that, from a historical viewpoint, have come into play because of long-term cycles crises that have been experienced consistently in most developed countries, and subsequently the impacts of globalisation of economies and information systems on scientific planning and management.
- An attempt will be made to identify themes on which interactions between research and policy might be improved and so lead to the realisation of the needs and wishes of society, without frustrating the scientific ambitions, careers and integrity of the researchers.
- To apply the general conclusions specifically to the problems being encountered in managing the environment, specifically, in this context, to research on the Mediterranean Sea, by examining some of the corresponding questions that have been addresses during the last two decades through European programmes.

2. Constraints and dynamics

2.1. Sociological approach

European research seeks to integrate the efforts of its great diversity of component research organisations. Some of these organisations are reputed to pursue pure science and are essentially preoccupied by broadening and deepening knowledge and understanding. Whereas others are orientated more towards R&D, developing new applications and new technologies. In practise both types of organisation have to find the correct balance between pure and applied science. The right balance has to be a compromise between pressures from the funding and supervising authorities who encourage the valorisation their achievements, and the aspirations of their researchers whose careers are often advanced more by their achievements in pure and theoretical science rather than its applications.

The criteria for positioning science in relation to these two approaches of the pursuit of knowledge and its application for the ‘good’ of Society are often difficult to apply, because in practice neither the organisations nor the researchers wish to appear entirely purely (basic) or purely applied. Institutions, whose scientific objectives are primarily devoted to the pursuit of basic science, proclaim the long-term utility of their researches. While those that are more orientated towards R&D, ask for recognition for their contributions to basic research.

At their level, individual researchers are under pressure to publish as many papers as they can on the results of their research in international scientific journals, and their rating within the scientific community (i.e. their promotion) depends very much on their success in publishing and disseminating their results and ideas. However, if they are to be successful in continuing to attract adequate funding, generally they must demonstrate the value of their research in terms of application.

This gap between assessment criteria for individual and collective research is surely a critical focus for our discussion, for in a sense to a large extent it determines

to a large extent stresses within the research structures. It implies that there is not only a double and sometimes conflicting assessment logic (publications versus patents and markets), but also dual criteria of evaluation (by scientific committees, which seek to guarantee the 'excellence' of the research versus management, to assign credit according to criteria of social and economic utility and to manage inadequate financial and equipment resources).

In this context the social demands appear as exogenous constraints, which change with development and prevailing circumstances. Whereas the pursuit of pure knowledge generates more endogenous motivations, the bases and development of which also need to be examined.

Up until the 1930s the expansion of knowledge progressed continuously and autonomously through a system of weakly co-ordinated initiatives and uncertain processes. Research began to be regarded as a 'social system' by Robert K. Merton in the context of his theory of 'structuro-fuctionalism' (Merton, 1942) which at the time represented the dominant thought.

During the 1960s, Thomas S. Kuhn introduced the concept of 'normal science' into conceptual framework of the sociology of science in the context of his 'scientific revolution theory'. At the time the accumulation of knowledge was the dominant paradigm. Detecting 'anomalies' or facts which 'normal science' could not explain, was then the driving force for modifying the accepted theory and hence bringing about 'revolutions' in the disciplines affected (Kuhn, 1970).

The sociology of science began to interest a larger public, especially as the issues got bigger. It gradually addressed the immense set of questions that Kuhn had posed, concerning the 'logic of proof', the scientific construction of scientific facts, the motivations of individual researchers and the strategies of scientific institutions.

These publications, especially the most recent, contradicted the idealistic idea that the dynamics of the research obey the four 'standards' that Merton considered conferred in Science all its desirable virtues of democracy (or transparency) and efficiency (its accumulative character and its rationality). These concerned the mechanisms of scientific recognition:

- The methods of peer review used by scientific journals in the selection of papers for publication.
- The process of allocating awards such as the Nobel Prize (Zuckerman, 1995).
- The identification of the social role being played by science in Society and the feedback of Society's influence on researchers both individually and collectively (Ben David, 1971).

The procedures underlying these evaluations could, at the time, be improved, by rapidly drawing on the benefits derived from the increasing role played by computerisation in scientific production. Thus bibliometric methods, soon called 'the science of sciences' (De Solla-Price, 1963) began to collect statistical data (inventories of researchers, numbers of periodicals, volume of publications, numbers of papers by authors, citation indices etc) whereby assessments of researchers, institutions, themes, specialities, disciplines and nations are now conducted.

However, the number of potential sources of social recognition and the variety of the procedures and indices (titles, salaries, decorations, power's attributes) make it hard to set apart individual and institutional motivations. Far from being able to draw objective conclusions from its assessments, the sociology of science nevertheless identifies that:

- At the micro-sociological level, individual researchers and institutions constantly feel torn between various objectives, which may not be opposing, but are still difficult to reconcile. Two main conflicts emerge, between the pure and applied goals of the Science, and hence between innovation (notably by trying to explain the 'anomalies' in Kuhn's dialectic) and classicism (conducting research on along the lines of the accepted paradigms). The notion of strategy turns out to be irrelevant to researchers and research teams. Their choices seem to be determined more by the context of their research (i.e. the current theories in their discipline) and their immediate environment of the research (i.e. the policy of their institutions), thus on blurred and constantly changing criteria that are often difficult to anticipate (Pollak, 1990).
- At the macro-sociological level, these studies contributed to a weakening of the mythical vision of Science itself (notably its objectivity and neutrality) by the researchers themselves as well as their institutions (their indifference to issues in research in terms of money and power). They treated knowledge as being merely a product of social engineering, but submitted to particular rules, that are linked to the intrinsic difficulty of gaining meaningful external assessments of its validity, value and procedures. Hence there was a necessity to foster consensus and co-operation between the actors.

This new, more realistic, concept of Science has not only changed the relationships between the actors but also Society's perceptions of it. Its issues have become negotiable, that is to say clarified and re-appraised rather than being treated as 'sacrosanct'. The issues also became more important, even essential from the economic point of view, in the short- to medium-term, in the development of technologies, and in the long term the regulation of its cultural, philosophical and political dimensions.

Under these new arrangements scientists do not appear to have lost out. There has been a normalisation of their relationships with Society, which has been accompanied by appreciable improvements in their conditions of employment and living standards. The image of the poorly paid and badly equipped research worker is a thing of the past in most developed societies. Thus they have exchanged aspects of their 'immaterial' power and influence for more tangible benefits in terms of better salaries and facilities. Thus there has been a consistent trend towards internalisation (in an economic sense) of all the externalities.

2.2. 'Historico-economic' approach

2.2.1. Time scales

Science and it actors have so far been discussed as if they are uniform entities, in order to point out some of the basic and constant elements of their strategies.

However, there is considerable variation both within and between the various disciplines according to the impacts of two types of influence whose effects and duration can be very different. On the one hand there are the 'fashions' of science that are often amplified by the media, and out of the control of the political authorities. Some disciplines experience only ephemeral exposure to such influences for weeks or months. Whereas others are constantly in the spotlight and so are exposed to long-term persistent trends, which last maybe for decades, and which can range from intense interest to complete indifference.

The short-term trends tend to affect the more specialised fields of interest, and are usually stimulated by current affairs. The longer-term persistent interest (or disinterest) can concern whole fields of scientific research (life on Earth, human and social sciences) as well as groups of disciplines whose bounds are defined by blurred criteria based on methodology or orientation (applied versus basic research; innovation versus improvement of existing technologies).

In these trends the respective influences of 'chance' and 'necessity', of endogenous versus exogenous influences are difficult to disentangle. The complexity of the interrelationship between Science and Policy appears on these two plains, and there are real mutual interactions rather than being a simple relationship with one approach determining the other. What has happened during the last 30 years in the fields of energy, the environment, and global development illustrates this assertion. A large consensus exists today in the analysis of events such that:

- A group of scientists, clearly acting as such, warned the governments of the Western World (notably through the Club of Rome) of the gravity of the problems that humanity will have to face, if they continued development as hitherto, blindly and without due consideration for the long-term consequences of their actions on social and natural environments.
- At much the same time a number of economic indicators confirmed that all was not well with the Western World and that the situation in many regions of the Third World continued to deteriorate. These indicators reinforced the message of the scientists, and at the same time there was evidence that many citizens were becoming suspicious and increasingly weary of the emerging 'consumer society'. As a result the warnings elicited considerable response in the media and had considerable cultural impact.
- The oil crisis of the 1970s induced a panic, which also had serious short-term implications in technical, economic and political attitudes, and also generated changes in longer-term sociological, cultural and perhaps philosophical attitudes.

Thus the role of some scientists during this transitional period when large parts of national and European R&D policies were developed, was clearly decisive, influential and globally positive. However, it remains to be seen what credit will be attributed to their action. Their message was very complex, and so was interpreted by the media and policy-makers in a great diversity of ways. Their forecasts were excessively pessimistic and were scientifically weak in many points. Finally many

huge new questions subsequently emerged which have altered attitudes in ways they could not have foreseen at the time.

2.2.2. Long-term analysis

Economic history can now bring some light to bear on our subject with some consideration of 'long-term economic cycles' to which considerable attention is being paid nowadays. This theory relies on observations carried out in the 1960s by Kondratiev (Fig. 2) who showed that since the Industrial Revolution several of the macroeconomic indicators for most nations in the Western World have undergone cyclical fluctuations with a periodicity of about 50 years. It was tempting to deduce that there was some endogenous cycle within the characterisation of these indicators determining these fluctuations. When checked and validated for the northern industrialised countries in Europe, it was concluded that this hypothesis showed convergence on many points with the theory of 'technological generations' which had been proposed

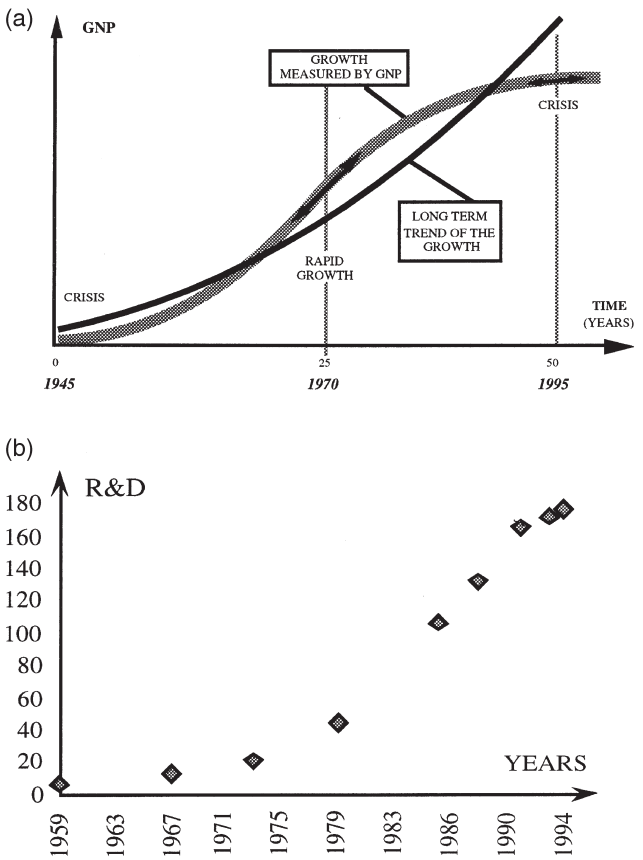

Fig. 2. (a) Kondratiev cycle. (b) R&D budgets in France (10^9 FFr).

by Shumpeter to explain similar cycles in a long-term analysis of the American economy.

The interest in these theories was to establish that the recent growth in the economies of developed countries was not a harmonious response by individual economies, but represented integrated periods of rapid growth. These are characterised by full employment of productive resources directed towards goals on which there was a broad consensus. These periods of growth alternate with periods of general crisis when unemployment soars and there is hesitancy about which objectives are appropriate. Naturally the transitions between these periods of growth and crisis last for more than a day. The main stages in the 'logistics of development' that need to be considered here are:

- The periods of emergence from crisis when there is a progressive re-mobilisation of the most productive resources (especially human) that had been left unemployed by the crisis, as result of emergencies and development of new activities.
- The progressively more accurate identification of the expectations of consumers, so that they can be more effectively satisfied. Initially, this experimental approach to markets is conducted by private firms, who start small. They insure the emergence of new goods and services, for which the intervention by governments is not justified, although they can stimulate the early stages of development of the corresponding technologies.
- The development of new infrastructures and satisfy other aspirations through investments in large infrastructures or equipment that are either so complex or so costly they need to support large communities. These activities correspond to the essential themes of development such as transportation systems, education, health and security. These tend to be focused on services and facilities that authorities do not want to leave in the control of private actors either for ethical or financial reasons.

There are periods of middle growth during which everything seems to be determined. Most actors seem to agree as to what should be done and care about improving productivity in terms of quantity rather than quality. Investments are initially focused on increasing production capacities to satisfy the growing demand and then shift to improving productivity (i.e. profitability). Political speeches tend to be clear, measured and very directive. Econometric models are considered reliable and forecasts come true.

- Expansion continues until the markets of the competing goods start to show signs of saturation. Then as competition begins to develop between rival firms those that are the least competitive will begin to close down and unemployment begins to rise. New values emerge during these periods when growth is slowing down, some of which define the themes for the new growth that will eventually follow emergence from the impending crisis (or recession). Defensive and offensive strategies are adopted by the surviving enterprises (modernisation, manpower reductions, flexible working practices, locating new markets, relocation to less

costly environments) that reinforce the trend towards worsening employment and stimulate the introduction of new technologies into manufacturing processes.

- During the peak of the Crisis confidence is undermined leading to feelings of wariness and hesitation that are as deep as they were boosted during the period of growth and expansion. These periods are marked by feelings of deep dissatisfaction amongst many of the actors while, paradoxically, growth still continues — a common characteristic of all the modern crises. As well as all the social problems associated with high unemployment, many basic (and political) issues arise about the redistribution of labour and wealth, and these serve to stimulate rapid growth in the new activities that leads to change in the cycle.
- Sooner or later, and not without sacrifices, Societies develop those activities that ensure there is a return to rapid growth and a re-allocation of resources around the occupations which integrate the new technologies. Hence the cycle returns to the phase of 'emerging from the crisis' described above. But this new phase has little in common with the previous one, except for the drive and energy of the actors seeking to re-mobilise resources (including human resources), and the increased will to co-operate in developing consensus about the new themes for progress, after 50 years almost everything has changed, it is a new world.

The role of politicians in this interplay is to sense the general mood of the actors, by constantly monitoring the signs that introduce new actors into the economy, and to help find solution to their problems and the means for them to realize their aspirations.

The relevance of this discussion on economic cycles is that Science, while being sheltered from the extremes of the social vagaries, is not entirely immune from them. The mechanisms of development determine the emerging 'policies' that serve to integrate the role played by politicians and the governments they lead.

The phases in the cycle of economic development generate very different ambiences in technical, economic and social fields, which in turn change the expectations of Society as to what is to be gained from scientists and scientific endeavors.

During the periods of rapid growth, the climate of confidence and economic well-being which enables new goals to be addressed is generally favourable to basic pure research. Conversely during the periods of retrenchment and slowing growth, the goals developed during the previous phase are questioned. A climate of economic competition develops that moves more towards applied science targets so that 'incentive programs' are preferred to recurrent financing. Those sciences that are able to solve the problems or help satisfy new expectations, according to the logic of the market economy, will find the means for their survival. These trends reach a climax in the 'middle crisis' phase, when paradoxically the uncertainties lead to more risk-taking so that those exploratory research projects that appear to be 'pre-competitive' progress. These end during the phase of 'emerging from the crisis', when the applied research comes to fruition and leads to improvement in the new technology.

For research themes, the correlation with the crisis cycle is less clear-cut, and very much depends on the contemporary status of the sciences in how they are perceived to be capable of resolving the current problems. Globally, and in any other context,

progress is aimed at improving people's life styles, through the development of new technologies, activities and goods, which, according to the creators of either quantity or quality, can always be improved. The themes can be defined as combinations of three essential dimensions of 'progress'.

1. Their Context: new activities linked to progress obviously sit between the material and spiritual dimensions of human existence, which define only activities centered on life itself — its biological and social aspects (e.g. health leisure, security) — its material aspects (e.g. environment, construction, equipment) and its culture (e.g. cultivation, education, training).
2. Their Criteria: evaluation of all activities and goods can be undertaken in many ways — power and efficiency of the instruments, qualities expected from the products (e.g. convenience, aesthetics), role in time and space (e.g. speed, ability, coverage, durability, reliability) according to the functions they perform.
3. Their Aims: advances (progress) may be made in two ways, either endogenously through problem-solving mediated by exchanges between the actors, or exogenously by increasing and/or diversifying resources and opening up new markets.

During the Crisis there is maximum indecision and hesitation about what should be done, and decision-makers are bewildered by the profusion of possible aims and proposals presented to them by the actors. They are faced with the dilemma of choosing between strategies of conquest or maintenance (of those who can stay integrated) and survival (of those who get excluded). The cognitive aspects of research are less in demand at such times and instead demands are made on the researchers to find solutions to Society's problems, either from the existing body of knowledge, or by targeting their research on 'the real contemporary problems'.

2.2.3. Effects on research trends and policies

The use of this concept of cycles must be used with due caution, and should not be assigned with greater validity than it merits. Its only interest is to enable thorough analysis of economic history with the wisdom of hindsight, and to characterise the various scenarios which seem to determine the behaviour of the actors and their management systems. In relation to the interactions between research and policies one can see that:

- Relationships between each scientific discipline and society fluctuate according to the phase of development and the economic environment, such that development in the disciplines may be in or out of phase.
- The various scientific disciplines lack coherence in the manner in which they respond and are perceived to be responding to the needs and expectations of Society.
- Scientific disciplines themselves are not homogenous. Even within a discipline there are significant divergences in opinion as to the important issues, trends and opportunities within the various specialisations. Increasing specialisation during the development of a discipline leads to researchers in the field developing

different attitudes to current issues, sometimes competing for resources to develop expanding themes or showing complete indifference to the activity of others.

As a result of all these sources of tensions and conflicts of interest, any 'harmony' that emerges within a scientific discipline tends to be transient and result from urgency enforcing agreement. Usually these periods of cohesion do not persist for long, but when they do they help the disciplines to evolve, and also sometimes reveal deep internal divergences.

This confrontation between the historical and current issues is one of the mechanisms that lead to the emergence of new disciplines and specialities. Splitting up is not the only possible outcome of such confrontation, instead there can be substantial restructuring often stimulated by applied research projects that leads to consolidation and different forms of integration.

The demands of Society are not directed at the sciences, but find their expression in the identification of the 'problems as they come'. Particularly at the time of Crisis these demands force re-organisation of scientific organisations to become more inter-disciplinary, more inter-institutional and of course in the context of the European Union, more international. Note that the 'state of the science' is neither independent of the policies, nor is it determined by it. A massive injection of resources (money, researchers and equipment) into a particular theme cannot guarantee that the researchers will deliver what is wanted or expected. Against expectation, important discoveries can originate from discrete or poorly supported areas of science. Thus policies can only modify the resources available to research certain thematic areas, and hence change the probability that the research is successful. However, the relationship between successfully gaining results and the investment of resources in science is rather weak.

Conversely the future of the discoveries that are made depends on their valorisation. No doubt many of yesterday's scientific results have been important in terms of the knowledge that was gained and their potential for application, but have not found, and maybe never will find significant outlets. Discoveries only appear to be 'great' through their applications. It remains impossible to predict when and where such discoveries will emerge, just as it remains impossible to forecast natural disasters and epidemics which may substantially alter Society's attitudes. The impact of AIDS (Acquired Immune Deficiency) and BSE (Bovine Spongiform Encephalitis) in the domain of health, exemplify just how serious and unpredictable such events may be. Similarly in international politics major crises, such as the Gulf War and the collapse of the Iron Curtain, can deeply disturb the course of world history, and hence perturb the evolution of science.

2.3. Geographical aspect

The long-term evolution of the global economy also strongly influences where the strategic development occurs and where the decision-making is undertaken. For example the period of rapid economic growth that followed World War ll was mainly controlled at the national level. Research policy (and economic development in

general) was determined exclusively at national level. But late in the 1970s after the Oil Crisis, the combined influence of the crisis and the development of the European Union, led to the transfer of legal and material competence either to the supranational level (i.e. the European Union) or to infra-national levels (i.e. to the regions within the individual nations). The universal application of the concept of subsidiarity was established in the EU during the 1980s with the aim of maximising the coherence of national Governments in public affairs, according to the motivations, competence and means of each actor. Subsidiarity is a concept that is difficult to apply to new problems, particularly if there is a mismatch between their geographical areas and the regional administrations. Thus most environmental policies, whose relevant scales are determined by nature rather then political boundaries, often require new forms of co-operation between several organisational levels of administration (Fig. 3). For example management of water resources is a major issue in the Mediterranean and is a good example in which the relevant scales involving basins, rivers, groundwater resources, lakes, seas and oceans is difficult to reconcile with the regional, national and international governmental organisation.

Research policies relevant to global scale problems and issues should be conceived at a supranational level, assuming that the corresponding legal and technical competence exists, rather than left to the unco-ordinated initiatives by individual governments or groups of nations or to the whims of benevolent billionaires.

Conversely regional policies should be defined as components of a balanced co-operative programmes between regions which are integrated (in the case of the Mediterranean) at the national and European level, around shared interests. Thus, neither control from the highest level (top–down) nor from the lowest regional level (bottom–up) should dominate. These two approaches will need to combine within the philosophy of subsidiarity, rather than to oppose it.

Thus spatial scale has to be taken into account both in scientific and R&D policies to ensure that they are both relevant and efficient. In recent years specific budgets

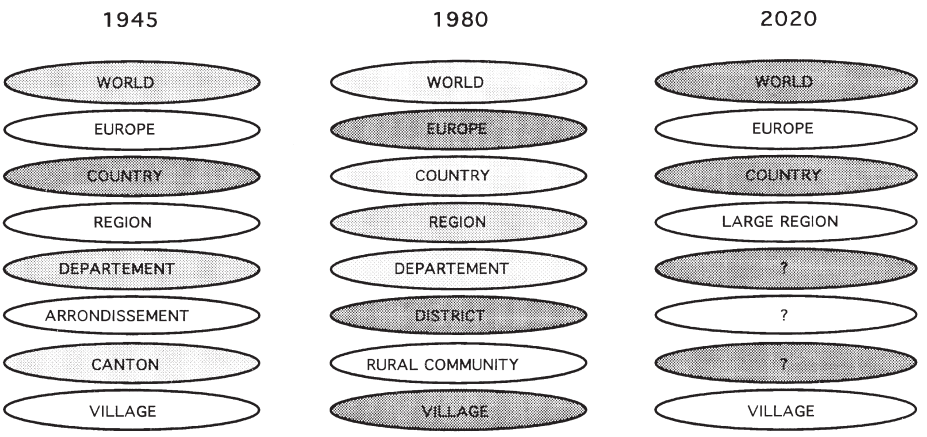

Fig. 3. Evolution of the ‘strategic’ levels of development.

for R&D have developed significantly at the World level, mostly in the context of the United Nations but also through private foundations, as well as at the level of regions (both through subdivisions of nations and co-operation between groups of neighbouring nations), to address specific mutual problems and hence lead to a narrow co-ordination between policies.

3. Interactions

3.1. The nature of interactions

Beyond the necessity of taking into account time scale (from the daily requirement of management to long-term planning) and space (from local to regional to global), the process of development described above has led to a proliferation of the systems involved and their interactions. The complexity of the whole system is constantly increasing, which implies that:

- No systems is entirely autonomous, each depends to a varying extent on the others.
- The systems are linked by a wide range of relationships, which differ in their content and intensity (being more or less direct, frequent, visible, explicit, materialistic or virtual etc).
- Market relationships between the actors are not sufficient to determine all the interactions. In other words, externalities increase particularly at time of crisis, which reinforces the feeling of helplessness of economy to control the complexity of realities.

Money appears to be the best tool for resolving conflicts of interest and indecision between the many and varied projects. It provides an effective way of regulating the competition between the current projects undertaken by a society, through implicit arbitration of actors through their expenditure on goods and services and on the various markets. However, money and market forces are not enough to be effective in control, so other safeguards are needed to restrict the materialistic logic, which is often simplistic, and blind, that they engender. Authorities assume a role in this task through laws and regulations, under which all citizens are supposed to be equal. The media, religion, lobbies and networks also play some role in the resolution of these conflicts.

Thus the most decisive influences in the long-term (cultural, ethical, philosophical, religious etc) are neither the most intense nor the most visible influences in the short-term, nor are these influences always consistent with policies and market forces. The mechanisms whereby they affect their influence are difficult to work out, acting either as driving forces (for example through desire, curiosity, lure of profit) or as restraints (through guilty feels or unreal perception of risk). We will now try to address how they influence the issues that affect research and policy.

3.2. Influence of policy on research

The system of R&D appears to be complex and unwieldy, and sensitive to many kinds of pressures and directives, and whose control would be shared between many controllers. For all that, policies are still directed at influencing it to develop so that it serves the best interests of Society. But these controls operate at different levels of organisation in the exogenous part of their motivations. Thus:

- European R&D financing is, for its part, justified by a logic derived from a coalition of research structures forming against the hegemony of Europe's main rival economies, and involves the focusing of resources towards a limited number of specific objectives. The key words for action in this context are subsidiarity and pre-competitiveness.
- National financing tends to promote basic research at the level of national structures and pre-development of its applications. This includes the management of intellectual and industrial property rights, whose issues are important to the national economies.
- Local and regional financing tends to direct research towards specific themes that the local authorities feel able to help develop, in the current logic of competition between economic spaces. This financing often supplements private funding to support the emergence and expansion of small enterprises, which largely depend on the proximity of services (provision of services to individuals, local businesses and communities).

Beyond these exogenous and specific concerns at each organisational level, the main endogenous objectives of policies are those that the relevant authorities assert are common to all levels of organisation, and are naturally orientated on improving quality of life for most citizens. Also, during periods of crisis, they are used to counter unemployment through job creation in the new fields of activity. In addition to their financial competence, authorities can influence the direction of R&D through rules and regulations, which can either increase, reduce or even eliminate interest in a theme. This approach is most efficient in dealing with R&D into the environment, where vast markets can be created by very simple new rules (for example concerning the management of water and wastes), or in the domain of life sciences in which important themes and applications of research can be drastically modified (for example in the domain of genetics). Corresponding policies, 'brutal' by definition in that they determine obligations or bans, are often delicate to implement and difficult to co-ordinate between authorities at different organisational levels.

So, the influence of authorities on R&D is based on either the classical financial tools (taxes, exemptions and subsidies) or regulatory or moral criteria. These concern all the actors, as on specific research policies they may result in direct orders and budgets. In every case, regulations and funding appear to be the main vehicle for the expression of public power and control. However, in view of the number, diversity and dispersion of the actors and the complexities of their strategies, these tools provide only partial control of their interplay.

3.3. Influence of research on policy

All relations by definition involve exchanges, but these are generally not equally balanced between all the parties concerned. The common logic is for each of the actors to contribute what he (she) has to valorise (or reject) and to extract from the relationship those aspects that he is lacking (either through need or desire). The fact that policies are defined by the authorities confers on them both authority and financial capacities that are of concern or interest to the actors in R&D. The actors, for their part, just have to offer their work, skills and tools. The asymmetry in these relations is large with the material and temporal values being brought into play by one side and the more abstract offsets that they imply by the other.

In return for the 'hard' values staked by the authorities, researchers and their partners in R&D constantly have to negotiate in various ways the 'soft' and subtle issues raised by their competence and abilities. These negotiations may take place through direct contact either when the researchers are consulted by decision-makers to enlightened research policies, or when they themselves solicit funding. Although normal, from a sociological point of view such relationships can generate problems associated with efficiency, transparency and neutrality on the consultations. Firstly because authorities demand priority for applied questions from researchers who are mainly recognised for their skills in basic research, and secondly because the process through which the scientists solicit directly through frequent meetings with authority's representatives can eventually lead to questionable practices (court effects, subscriptions) which generate inequalities in the opportunities for potential benefits from public subsidies.

The European Commission in its last PCRD, and most of the ministries within the individual countries who manage the main research budgets, assess the scale of these problems and implement procedures to try and neutralise them (Valette, 1996). However, many of the other authorities at both local and international levels still have a lot to do to improve the transparency and fairness in the way they allocate their subsidies. Direct and visible relations remain desirable but it is uncertain if they provide the essential mechanism whereby research can influence policy. There are other modes of influence that exist via third parties who are either actors or systems that are not explicitly involved in R&D (see Fig. 4). The mechanisms of their action is hard to work out, either because they are vague or unstated (i.e. cultural, ethical, moral and religious beliefs) or because of the complexity of the relationship involved. Nevertheless they are essential at the decision-making stage.

The media play an obvious role in these interactions. By informing people and discussing the issues they contribute to the development of public opinion about the current issues, as well as directly influencing the decision-makers. No domain of research escapes this influence, and the media can assist or frustrate the wills and opinions of both the authorities and the scientists. There are numerous examples of how this influence affects all sectors, often involving massive budgets, such as in agronomy in the 1960s and 1970s in response to famines, the impacts of the oil crisis of the 1970s, in medicine new alarms associated with AIDS, BSE, cancer and genetic disorders, and most recently the role science can play in coping with and

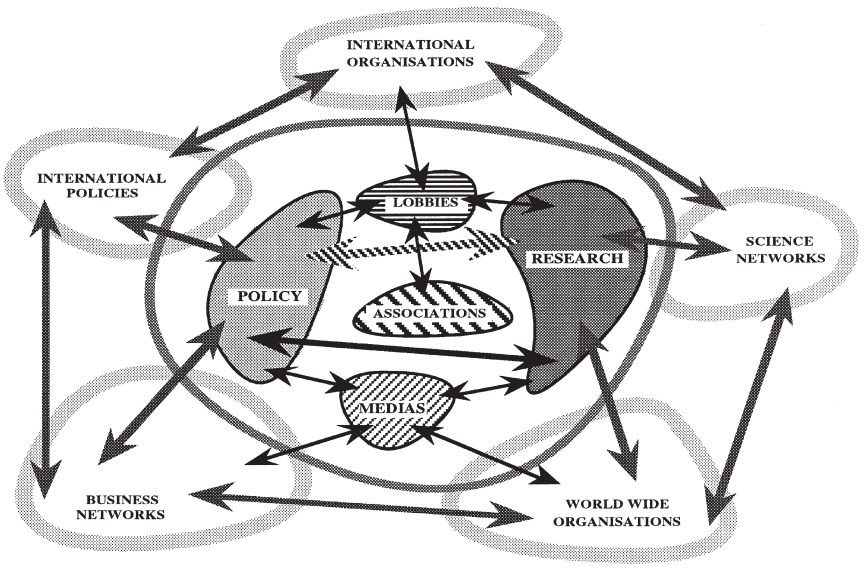

Fig. 4. The multiplicity of actors, direct and indirect, the R&D.

resolving the problems of the environment. Without being in their pay, the media rely on the expertise of scientists to inform them and provide guidance on the issues to campaign. Thus scientists play a key, indirect, but influential role on orientating policy.

Apart from a few historical exceptions, during which public opinion misled by some foolhardy scientists ventured into policies which wasted funds and resources, democracies have nothing to fear or complain about such interactions. Because of them authorities are able to pay attention to the expectations of most people, and even if some funds get wasted, they have been spent to satisfy real demands of people, which is surely less offensive than other forms of waste which are only justified by the fads of technocrats or untouchable politicians.

3.4. The nature of the exchanges

As well as the statutory channels of influence there are many other mechanisms whereby research and policies interact through transversal logic motivated by interest groups — networks, clubs, lobbies, families and other action groups. The roles of these special interest groups are not always clear, but everyone involved knows that they condition many aspects of the strategies of actors. In a sense this comment is to point out that science responds/does not respond to authority in an obscure manner, nor can authority necessarily manipulate the science as it might wish. The reality may differ a lot from the classical, idealised concept that scientists simply exchange the knowledge, know-how and projects for salaries and credits, and sometimes to face current problems or to foresee future problems. In fact the exchanges are more

diverse, extensive and unstructured than Fig. 5, which tends to differentiate between 'hard' and 'soft' influences.

All the issues of these relations are generally seen as essential by their actors. Consideration of the interrelationships of the usefulness of each component and that it assumes that there is mutual recognition of the usefulness of what is done by each, together with a realistic understanding of the complexity of the various roles that are exclusively positive rather than intransigent. With this kind of hypocrisy one should not be naïve about the fact that:

- Policy-makers need scientific backing rather than mere advice or recommendations by scientists in support of their actions. Scientific institutions need a moral authority and have to be politically neutral, because their advice should be based on objective interpretations of the facts. The elected representatives of authorities always perceive their approval as essential, if the quality of their projects and actions for the good of Society are to be recognised, so that they can stay in power.
- Scientists also use policies to finance the research they wish to carry out and so realise their ideas and projects. Beyond their general needs for money and resources, they expect the policies to generate for them recognition of the utility of their work, so that there is justification for their employment and salaries. Credits that are gained from these policies can be used as the basis to initiate and conduct some 'good' (basic) research, on which ultimately their careers will be founded.

Thus R&D policies lead to strong interactions involving various kinds of values (money, knowledge and power). More precisely there are exchanges of concrete values for less tangible ones, whose flows are clearly not symmetrical, but whose sense remains consistent (means come from policies, and knowledge comes from

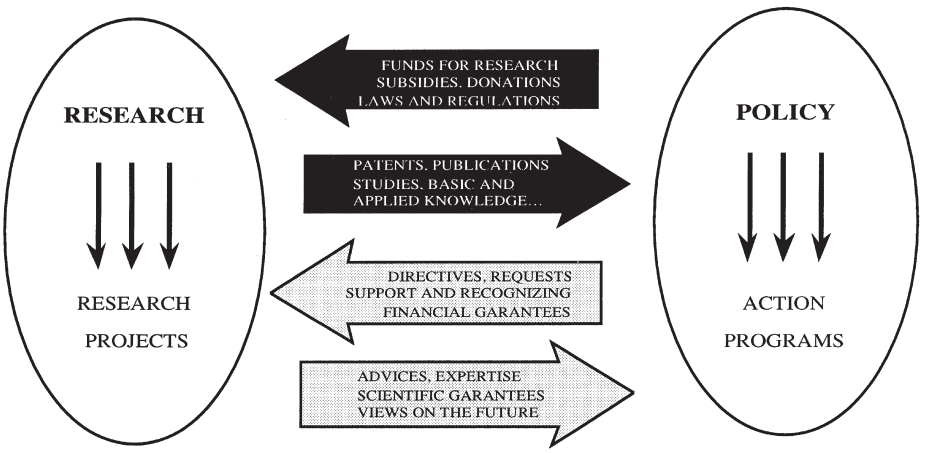

Fig. 5. Trades, concrete or abstract.

research) and whose long-term equivalencies are mutually accepted, and indeed have to be if their relationships are to continue.

The potential power of scientists is considerable, if they can find markets or at least they are listened to; just as authorities can rely on retaining power and influence if in the long-term their policies have to be enforced by laws, police and money. The association between science and policy-makers invokes the parable of the blind and the lame; each requires the other. But there the analogy stops, because each is reliant on others in order to act.

The contradictions evoked above help to explain many of the frequent tensions that build up between mangers of institutions (whose actions tend to express the will of governments by which they are appointed) and the committees of assessment (which can only make scientific recommendations and for the most part are composed of researchers and are selected by their peers). These complex factors explain why the ministry of research is only that of researchers and does not include Industry and Finance. The Japanese example of an overarching ministry which integrates education, research and industry (MITI) can be effective during periods of growth when there is general consensus between all these fields. However, the signs and causes should not be confused, this example only functioned in Japan at a particular historical context. To combine these functions artificially is not enough to guarantee their synergy. Economies can be made by such associations but only when they have common global objectives.

4. Application to the environmental policies and to the Mediterranean

4.1. General observations

Insofar as the environment is concerned, the discussion above has been deliberately general. There is a particular interest in the theme of the environment in synthesising the many problems facing modern Society (as is also the case for culture, health and security). 'Environmentalism' seems to have been born inmost of the developing countries during a critical period during the time of transition from growth to impending crisis, i.e. at the point of inflexion in the growth curve that these countries experienced after World War II until the 1960s.

The strength of this environmentalist movement probably found expression simultaneously in all these countries because of:

- The demotivation of many of the basic actors in the development of many of the themes of the previous growth cycle, following their satisfaction of most of the expectations in terms of material consumption.
- An increasing concern expressed by many citizens that progress has detrimental long-term as well as positive short-term effects. This gave rise to an increase in criticism of the logic of development in which the detrimental impacts were ignored by the classical economic analyses.
- The pique expressed by many scientists, notably in the life and earth sciences, that

their contributions were no longer being implicated in the decisions and actions of governments which were listening more to engineers and businessmen despite easily identifiable flaws in the dominant management models.

- A strong mobilisation of a younger generation which was affected by the autocritical scepticism of the older generation, and also full of idealistic fervour to resolve newly emerging problems in Society and spurred on by certain gurus, who exploited the situation.

Politically there was a rare convergence of ideas from scientists and new demands from Society that focused the new R&D policies on new technologies and new markets for products and services. It took some time, while the crisis intensified for these fresh attitudes to be taken seriously. It also took a lot of serious reflection, as well as experiences and actions at all levels of organisation to transform the potential of this idealism into reality. Their impact has only started to become significant in terms of employment in some of the developed countries. The organisation of the scientific community did not appear to be a model that could efficiently restructure itself and propose solutions to the problems. Even now it appears to be divided on many of the issues and unable (or unwilling) to marshal its skills and abilities. This is probably because of currently its disciplinary structures and assessment rules remain inappropriate to address the emerging questions that require interdisciplinary and global approaches.

Today, most of the issues are still being debated at the level of the individual disciplines, and at scales that range from local to global. The debates are beginning to identify the main issues and the key actors, and the policies are being established with appropriately large budgets. Occasional large international conferences (Rio, Berlin, Kyoto and Caracas) are uncovering some of the global issues and revealing the deep difficulties of reconciling the interests of all in order to take real decisions at this scale. However, similar, more frequent, local, sectoral and special issue meetings have repeatedly demonstrated that reconciliation between sectors of science, business and government are just as difficult at smaller scales and likewise have not been achieved.

4.2. Issues pertinent to the Mediterranean Sea

Up until the end of the 1960s, although the Mediterranean was considered, historically and economically, as an entity, it was able to attract many kinds of resources from northern Europe from those who wanted to take advantage of the remarkable quality of its products, atmosphere, culture people etc. Its relative economic backwardness was also attractive for long-term investment. It was then, above all, the subject of sectoral approaches and studies aimed at economic development more than the conservation of the quality of its resources. As with many other large ecological systems, it began to be considered as an ‘environmental entity’ with the emergence of environmentalism during the 1970s, when some scientists began to warn of the risks associated with the current development, particularly from various kinds of pollution.

The intensity of the damage being caused (by erosion, loss of coastal habitats through construction, increases in the incidence and severity of forest fires, dramatic pollution of the sea from rivers, ships and local activities, and over-fishing) provoked many, but scattered, protests from local actors. However, as with other themes and in other areas of the World, it took over a decade for these concerns to be translated in relevant programmes of research and action. Once again scientists experienced considerable problems in co-ordinating their efforts within the programmes that were so badly needed.

Today the Mediterranean area is now considered by public opinion, science and the authorities as an ecosystem that has to be studied and managed globally as well as locally. This entails considerable co-operation between the many scientific disciplines, within the federal concept of 'sustainable development', which requires:

- Themes and procedures to be multi-disciplinary and integrated internationally.
- Spatial integration of the research and management of all the systems across the complete spectrum of scales.
- Similarly, integration in time must take into account the different scales in economic analyses, particularly in the evaluation of costs, risks, and externalities.

4.3. Impacts on actors and institutions

What happened during the last few decades concerning the environment and, specifically, the Mediterranean Sea has been consistent with the general model, which was described at the beginning of this paper. There was an evolution from its management being determined in the 1950s and 1960s by micro- (private) and macro-initiatives (national) so that its development was essentially rapid, short-sighted and poorly controlled. The problems of this poorly regulated expansion were scientifically recognised during the 1970s, and interest in these issues at mesoscale levels of organisation began to be integrated during the 1970s. The last European Framework programme for R&D attempted to continue this integration at all levels and to force the actors to co-operate more effectively. So this programme was local, regional, national and international in its scaling, which is surely a sign that we are entering a new phase in the cycle of development and we are 'emerging from crisis'.

5. Conclusions and perspectives

Research and policy are two domains in which the complex wills of both actors and Society are expressed. They involve the resolutions of many contradictions between short-term and long-term objectives, between local and global issues and between material and cultural values. Our discussion allows us to list some of the ways in which interactions between the various participants might be achieved.

5.1. Concerns for R&D programming

In R&D programming the current process by which the objectives of research and the missions of its actors are determined is still insufficiently transparent. Thus:

- Scientists must get more involved in the identification of the problems facing Society, so that they appropriate them (rather than suffer them) in to their programmes and devote their energies to solving them, rather than denigrate and avoid them by escaping into the solution of more theoretical and esoteric problems.
- Other actors in Society (business, consumers, communities etc) should be better and more persistent in expressing what they expect Science to provide, so that their expectations can be translated into prioritised scientific problems.

It would neither be appropriate for researchers to consider the social demands only to emanate from politicians who claim to know what the voters expect just because they have been elected, nor from pressure created in the media, in which the decisions as to what should be debated are guided mostly by audience ratings and the potential for 'word-bytes' and catchy headlines, than any objective evaluation of situations. Nor would it be any better to rely solely on sources that are either too endogenous (research committees) or too exogenous (market forces). By definition, as the object of the collective interest, whose long-term interests are the environmental capital, R&D should be the theme of wide-ranging and open debates. These debates should mobilise the whole network of actors ranging from producers to users and from scientists to managers, rather than rely on the decision of small groups of decision-makers no matter how clever or powerful they may be.

However, such democratic ideas are easier to state than to put into practice. They do become more of a reality, for example in the context of larger attempts to communicate science organised by governments or, at the European level, to open the programme communities to representatives of user groups who are not necessarily authors (scientists or managers). However, laudable though these efforts are, they tend to be only symbolic stages in a long drawn out process, that ultimately can only be improved through extensive experience.

Human and social sciences (history, philosophy, sociology and economics) should play a larger role through systematic interaction with others. Furthermore, local and regional authorities and representatives of the beneficiaries should play a role in orientating the R&D that concerns them.

5.2. The co-ordination of R&D activities

Beyond their planning, some recommendations can be made in making savings, i.e. in improving efficiency. These concern better co-ordination of all stages of the process (allocation of roles, subsidies, organisation of tasks, assessment of outputs and valorisation of results) and the relationships between all levels where R&D is carried out:

- At political and geographical organisational levels, ranging from the European Union to local authorities, there are barriers resulting from cultural differences and from their implicit hierarchies which often engenders a mixture of distrust and yet fascination. However, co-ordination encounters is severest problems when dealing with the complexities of civil services and because of remoteness generated by the multiplicity of organisational levels between those who conduct the research and central authority.
- In the sectors of activity (teaching, training, research, industry and services) co-ordination can be improved, ideally at all levels, but realistically at the national level of ministries.
- Between the scientific disciplines at the level of research institutions, because social demands are independent of these divisions. Such demands often concern several, if not all disciplines, as is so for the environment, so researchers should be more even-handed in their claims and displays of competence.

Finally, there are the traditional calls for greater clarity, improvements in organisation, greater mobility (geographically, statutory, and functional), flexibility, transparency and concentration of resources. The diversity of approaches that is so often needed, make it necessary to maintain healthy exchanges between all the actors in the game, and to explore the problems through a wide spectrum of methods and cultural approaches.

To conclude on an optimistic note — we notice that the universal suffrage combined with enabling power of new technologies has permitted Science to emerge from being a totally closed activity (run by elite and secretive cabals, with goals set by ‘princes’, and the benefits accruing to an aristocratic minority) to being almost globally open (published results, goals fixed by representatives of Society, assessment publicised, benefits more widespread). Even so, there is still ample room for improvement, although there are many mechanisms retarding these trends. These include networks and power circles (associations and clubs), systems of co-option and exclusion (through the concept of scientific excellence), secrecy (because of military or industrial interests) and even prohibition (on ethical and moral grounds, although these are often subjects of recurrent debates). However, at the same time that decision-making and assessment procedures are improved, entrusted institutions and individuals are becoming endowed with growing authority. If these are not to become ossified, out-of-touch or imbued with prejudice, they must receive only limited term appointments. However, the ephemeral nature of their responsibilities will inevitably disturb their individual and collective judgement, either because it is prescribed (i.e. as non-renewable missions, so that decision-makers force a rhythm to their actions) or because it is subject to election (in other words judgements are coloured by popularity, the need to be re-elected, rather than seeking the optimum solution).

So evaluation processes are becoming progressively more collective and sophisticated, and so increasing the distance between leaders and the actors, and to bias the decisions against difficult long-term solutions in favour of the quick short-term benefits. Thus we may be lacking those qualities that characterised some of the ‘princes’

(i.e. institutions whose power is fixed rather than determined by powerful and often cultured people) who were able to face up to long and very long-term issues. How such authority's decision-making is to be created remains to be defined, but it will probably have to be conceived at the global level, which is becoming the critical scale for research.

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