Setting concepts into motion:
Sustainable Development and R&D policies

Development of scientific tools in support of
Sustainable Development decision making

Workshop – Brussels
Hotel Astoria
28 – 29 November 2001

Proceedings

Edited by M. Vanderstraeten

Setting Concepts in Motion:
Sustainable Development and R&D Policies

D/2002/1191/20
Brussels May 2002

Setting concepts into motion: Sustainable Development and R&D policies

Development of scientific tools in support of Sustainable Development decision making

Workshop – Brussels
Hotel Astoria
28 – 29 November 2001

Proceedings

Edited by M. Vanderstraeten

Setting Concepts in Motion:
Sustainable Development and R&D Policies

Preface

The workshop “Setting concepts into motion: Sustainable Development and R&D policies – Development of scientific tools in support of Sustainable Development decision making” took place in the Astoria hotel in Brussels on the 28th and 29th of November 2002. It followed upon the workshop “Sustainable Development and R&D policies” held in Bonn on the 1st and the 2nd February 2001. The Bonn workshop initiated a broad discussion on current and future developments of R&D policy in support of sustainability in view of the implementation of sustainable development and the role of R&D policy within Europe.

Since the Bonn workshop, a stepping-up of European sustainable development policy has been witnessed with the Stockholm Conference “Bridging the Gap” in May 2001 and the European Council of Göteborg in June 2001. The former focused on the integration of sustainability into different policy sectors. The latter agreed on a Strategy for Sustainable Development. This Sustainable Development strategy needs to be scientifically underpinned by adequate scientific tools and methodologies.

The Brussels workshop brought together approximately 70 European R&D policymakers, research programme managers and representatives of international organisations.

On the first day the presentations and the debate were focused on research policy instruments for Sustainable Development. The impact of the latest EU policy papers on Sustainable Development and on R&D (EU research instruments next Framework Programme, Art. 169) were at the fore. Particular attention was paid to Art. 169 as an instrument and to potential topics of Sustainable Development to be implemented by Art. 169.

The main topics of the second day were scientific methodologies and tools for underpinning a Sustainable Development policy, which deal with economical, social and environmental policies in a mutually reinforcing way in such context as in sustainable impact assessment (SIA). The second day of the workshop provided an overview and classification of various existing tools used in Sustainable Development research, experiences with and usefulness of these tools and examples of case studies that have implemented and/or developed tools. The final discussion round centred on the need for further research in this context and how to go beyond.

The workshop was organised by the European Commission[1] and the Belgian Federal Office for Scientific and Cultural Affairs with the support of the *Institut de Développement Durable*
It was funded in the framework of the Scientific Support Plan for a Sustainable Development Policy I – Supporting Actions (contract AS/F5/16 – “Modelling in support to decision making for sustainable development”) and of the European Commission's Environment and Sustainable Development Programme - Accompanying Measures (contract EVG3-CT-2001-80001 – STSD)

Acknowledgements

We gratefully acknowledge the work performed by the speakers, the chairpersons and the rapporteurs.

For the logistic and organisational support we would like to thank in particular Monique Blanken, Alexandra Vildaer and Anne Depauw. The latter also contributed to a great extent to the editing of the proceedings. We also thank the staff of the financial department of the OSTC.

[1]For the European Commission: Irene Gabriël (national expert), Per Sørup (Head of Unit) and Pierre Valette (Head of Unit))
For the Belgian Federal Office for Scientific and Cultural Affairs Martine Vanderstraeten with the support of Nicole Henry and Hilde Van Dongen
For the *Institut de Développement Durable*: Paul-Marie Boulanger and Thierry Bréchet (now at the Université catholique de Louvain-la-Neuve)

Table of contents

Welcoming speech

(Presented by Nicole Henry, Head of the Research Department)

Eric Beka

Secretary-General

rue de la Science - Wetenschapsstraat 8
B-1000 BRUSSELS
www://belspo.be

Ladies and Gentlemen,

First of all, I would like to excuse Mr Eric Beka, the Secretary-General of the OSTC for not being able to come today.

I wish to welcome you to Brussels and to thank you all, and in particular the speakers, rapporteurs, and chairmen, for showing your interest by joining us and working with us before and during this Workshop. The Workshop is jointly organised by the European Commission, its Directorate-General for Research, IPTS in Sevilla and the Research Programmes Department of the Belgian Federal Office of Scientific, Technical, and Cultural Affairs.

This workshop around sustainable development and research and development policies is intended as the follow-up of the Bonn meeting. The meeting that was held in Bonn last February provided a wonderful stepping stone.

Regarding this follow-up, the participants in Bonn agreed unanimously the initiated discussions and exchange of information should be intensified, and that the concepts emerging from the meeting should be made operational. This is why we are here for two days now!

We are aiming for an intensified discussion on priority issues in this field and for a relevant exchange of information. I would be extremely elucidating to have an "around-the-table" discussion with you, all experts in the field, in order to come up with new insights on research concerning sustainable development issues and new research policy instruments of the European Union.

The OSTC has been involved in this field since the early nineties through several programmes.

In 1996 the First Scientific Support Plan for a Sustainable Development was launched – one of our main research programmes. This particular programme will be concluded at the end of this year. The Second Plan recently started and will run to the end of 2005.

I personally hope this will be a fruitful Workshop. I thank you warmly for your attention and wish you a pleasant stay in our country.

Before we take off with the actual contributions of our speakers, I would now like to give the floor to Mister Wisenberg, the advisor of Government Commissioner Mr Yvan Ylieff.

Welcoming Speech

(Presented by Jacques Wisenberg, Advisor)

Yvan Ylieff

Government Commissioner attached to the (federal)
Ministry of Scientific Research

Square de Meeus 23
B-1000 BRUSSELS

Introduction

Ladies and Gentlemen, it is an honour for me to welcome you to Brussels and to the old-fashioned setting of this "Belle Époque" hotel. I am happy to introduce this two-day workshop on research and sustainable development, so important for current and future society, for the people of the North and South and for decision-makers at all levels, local to global.

In the framework of my competence as Government Commissioner for Scientific Research, I shall limit my talk to presenting the context of this Workshop, which is to deal with the interactions between research and sustainable development.

I will introduce two topics: the rapidly changing European policy with respect to SD and with respect to R&D and its consequences for research and the content of the Workshop itself.

European Policy and its consequences for research

First, let's look back on the history of the concept of sustainable development. As you are all experts, I will be brief and limit my presentation to a few important milestones.

Strategies intended to foster sustainable development go back to the 1987 Brundtland report in defining sustainable development as a concept with multiple dimensions. - this was a first call to decision-makers to address the issue of the quality of the development of society today, and especially in the long term. - and in 1992: the UNCED 92 better known as the Rio conference and its Agenda 21, which began to concretise a concept that to some seemed vague and inapplicable.

Since Rio there have been many questions and reflections, but Europe made the first major step with the treaty of Amsterdam and its article 6. With the European Council of Göteborg in June 2001, we witnessed a stepping-up of European sustainable development policy.

What progress did it bring about?

The Lisbon Summit in March 2000 laid down new general policy and research policy guidelines aiming to make the European Union the most competitive and dynamic knowledge-based economy in the world, an economy capable of creating sustainable growth with more and better jobs and improved social cohesion.

In June 2001, the European Council in Göteborg agreed on a Strategy for Sustainable Development that the European Commission had prepared at the invitation of the Helsinki Council in December 1999. The Göteborg Council Decision added an environmental dimension to the Lisbon Council Decision and emphasised that sustainable development requires dealing with economical, social and environmental policies in a mutually reinforcing way. The Göteborg Council drew the remarkable conclusion that failure to reverse current trends threatening future quality of life will greatly increase the costs to society or make those trends irreversible.

I also want to mention the White Paper on European Governance published last spring, and specifically one of the scientific reports entitled "Democratising expertise and establishing European scientific reference systems" on which the White Paper is based.

From all these considerations we can draw some preliminary conclusions:

- sustainable development has acquired an important place on the political agenda of the European Union;
- faced with new challenges for society, decision-makers are calling upon science and research.

But what do they expect of research and how should science and research be organised and funded?

Support of research to development is not new. Traditionally, even when research was not organised and stemmed essentially from the genius and inventiveness of individuals, it led to new knowledge enabling society to improve health care and develop new products and processes. The new challenges society must face, such as how to respond to its own development or to situations such as the BSE or "mad cow" crisis, require more structured research. Sustainable development likewise requires integration of the social, economical, and environmental dimensions equity, uncertainty, sectorial interactions…

In response to these needs, the Commission proposed in January 2000 the creation of a European Research Area. Its objectives are:

to initiate a debate on the organisation of research,
to stimulate innovative areas of research and technology,
to create a federating effect promoting co-ordination of the Member States' efforts at national level.

Implementing this Area will require the use of new tools, and notably:

projects and the constitution of project clusters.
networks of excellence, of which Belgium's Inter-University Attraction Poles, with a budget of EUR 111 000 000, are a good illustration ;
integrated
We support however the EU Ministers meeting on October 30th that struck a deal to continue the use of existing mechanisms and to establish the ERA progressively and the new tools introduced gradually through pilot projects. An evaluation of the results would give us a better picture of what should be done in the future.
After these general considerations, let's return to the essence of this meeting: the importance of research in to underpin a sustainable development.

The conference «Bridging the Gap» held in Stockholm in May 2001 stressed the importance of research in support of decision-making.

I wish to stress that an integrated and multi-sectorial approach in a holistic context, and taking into account the precautionary principle is a prerequisite to sustainable development. In research this translates as inter-disciplinarity.

Furthermore, implementation of the sustainable development concept cannot ignore globalisation and its effects at multiple levels: economical (for instance, in establishing international trade regulations), social (notably in efforts create decent working conditions for all, in both the North and South), and environmental. In addition to support from research, decision-making for sustainable development thus requires taking into account the needs of society as a whole.

Even more than other problems, sustainable development requires the use of rigorous tools for guiding policy decisions: models (both theoretical and applied) for understanding and describing how systems operate and tools in support of making policy decisions and evaluating implemented policies.

It is becoming increasingly important to involve stakeholders and the public at the very outset and throughout the decision process to arrive at the implementing a sustainable development policy. Policymakers often ask scientists to provide clear, quick answers. But an interdisciplinary approach, the integration of results and the peer review take time and do not always allow clear answers to complex problems.

As these methodologies and scientific tools emerge, there must be a dialogue with policymakers to ensure that the right question is being addressed and to get input on the latest policy trends. More communication is needed, possibly through intermediaries, to test whether knowledge is being used in the right way and whether, in the light of the evolution of science and policy, an iterative process should be continued.

In the framework of the activities of my administration, the objectives of the first and second «Scientific Support Plan for a Sustainable Development Policy» carried out since 1996 have notably included the development of decision underpinning tools in the area of sustainable development. This experience can be exploited in the context of European activities and will be I hope an interesting contribution to this Workshop.

I would like to end this first part of my talk with a warning to decision-makers in the research field. The use of research in decision-making must not reduce research to a mere instrument, but must leave space for basic research. A balance must be sought between basic research and policy-supporting "utilitarian" research.

Clearly, the issues that bring us together today are vast and complex. Yet we intend to tackle them and to identify potential lines of action.

Introduction to the Workshop

This Workshop is intended as a follow-up to the Bonn Workshop held in February 2001. We shall address certain points of the Bonn Memorandum and examine in more detail the key issues raised in Bonn. We have chosen as the main focus "Scientific Tools in Support of Sustainable Development Decision-making", tools that take into account as many different characteristics of sustainability as possible.

The Workshop is taking place at a crucial moment, because the next Framework Programme is in preparation and the instruments for implementing the European Research Area are being discussed. We must seize this occasion to identify Europe's strongest expertise and top-priority issues, to examine which science policy instruments are best suited for sustainability research, and to develop links between national programmes in view of networking for greater consistency and co-ordination.

Let us now examine the Workshop agenda.

Day 1 will be devoted to discussing the impact of the various EU policy papers on sustainable development and research. We shall also discuss national research activities and the research instruments to be implemented. One focus, for example, will be Treaty article 169 concerning the joint implementation of national programmes and projects. Day 2 will be devoted to informing R&D programme managers and policymakers on the state of the art in the area of scientific tools in support of decision-making related to sustainable development such as indicators, models, monitoring and assessment tools, etc.

The central question remains how to integrate the features of sustainable development into research (notably how to integrate all three pillars of the concept, solidarity within and between generations, the precautionary principle, etc.).

The first presentations will provide an overview and classification of the various existing tools, their possibilities, and their limits. They will be examined in relation to their potential usefulness in developing an integrated sustainability impact assessment Then various case studies will supply more detailed information concerning the results of the implementation of these tools: and their transferability.

The final discussion will focus on needs in future research and on difficulties to be overcome. We shall return to the discussion of the first day on building the European Research Area and on priority issues to be addressed jointly.

Conclusion

But the limelight today is on science for sustainable development! I realise that your task for the next two days is not an easy one. It will require your active and creative participation. I trust you to strive to make this Workshop a success, and I expect these two days to yield excellent results.

Good luck!

Sustainable Development research opportunities and perspectives under the next Framework Programme (2002-2006), including article169.

Christian Patermann

Director

Directorate General for Research, European Commission
200 Rue de la Loi, B - 1049 Brussels, Belgium
Chris.Patermann@cec.eu.int

The Göteborg process and the EU Strategy for Sustainable Development

The Göteborg process

- Adds environmental dimension
- Stimulates innovation and investment
- Requires research and technological development

Examples of European research

- Greenhouse gases (CARBOEUROPE and EPICA)
- fishing practices (OMARC)
- Monitoring (GMES)
- Wind energy (WEGA)

ERA, FP6 and the 6th priority

- To pool research capacities in Europe
- Three pillars of sustainable development

Sustainable Development in FP6

- Integrate environmental, economic and social objectives
- Priority 6: Sustainable Development :
  - Sustainable Energy Systems
  - Sustainable Surface Transport
  - Global Change and Ecosystems
- Priority 8: Planning in anticipation of future needs
- Priority 7: Citizens and Governance

New instruments

- Networks of Excellence
- Integrated Projects
- Use of article 169 of the EU Treaty

Issues for article 169

- Monitoring and assessment tools
- Common European evaluation criteria
- Best practices and their transferability

article 169 of the EU Treaty
"In implementing the multi-annual framework programme the Community may make provision, in agreement with the Member States concerned, for participation in research and development programmes undertaken by several Member States, including participation in the structures created for the execution of those programmes"

The European Context

Uno Svedin

Professor, Director of International Affairs,
Swedish Research Council for Environment,
Agricultural Science and Spatial Planning (Formas),
Box 1206, SE-111 87 Stockholm, Sweden
Uno Svedin@formas.se

Former Chair of the European Consultative Forum on the
Environment and Sustainable Development (June 2000 - October 2001)

An outline of the presentation

The topic is treated in the following way: first the flavour of European Sustainable Development (SD) Policy is outlined by giving short glimpses from the policy that was finalised in Göteborg, including measures agreed upon for onwards implementation. After that the characteristics of a science in support of SD is indicated. Using a comparison between the SD policy for Europe and the specificity of the needed R&D we move into the domain of the "match" between the two and what it means in terms of demand for European R&D tools and how they could be used. By tools is here meant something broader than those indicated already in preliminary versions of e.g. the 6th (research) framework programme (FP), or the European Research Area (ERA).

The flavour of EU Sustainable Development policy

After the Göteborg Summit 15-16 June 2001 it is much easier to define what the priority elements are than before, when only different patches were sufficiently consolidated. Now we can distinctly say that the strategic aim is that EU citizens shall be granted:

- economic stability
- social supporting conditions
- a clean environment

We can also distinctly say that the SD policy is based on all the three pillars, or dimensions of the SD concept i.e. that all new major suggestions for decisions have to be judged against their effects with regard to:

- economic,
- social,
- environmental

outcomes.

These dimensions should as well be seen as mutually reinforcing each other.
Structurally in the frame of EU agreements this means that the environmental dimension is to be added to the Lisbon Strategy which basically took care of the dimensions of social and economic development.

The follow-up of Göteborg is now scheduled to occur at the Spring Councils, which then has been given the task e.g. to assess advancement over a wide range of issues.

The reference to the 6th Environment Action Programme (EAP) is here of importance as it points at the way in which the environmental dimension of European SD shall be interpreted. But it is not only the 6th EAP that is referred to. Also the Commission's SD Strategy Document, including its design for implementation processes is referred to. Here we also find general goals and strategies for integration of environmental concern in EU sectors as important elements.

The reference to the need to "build an effective review of the SD Strategy" is very distinct. It relates to the operative connections to different policy areas (including 6 EAP) and the sector strategies for environmental integration. The stress on "the global dimension" is also very explicit, stressing the promotion of issues of global environmental governance, e.g. the trade-environment nexus.

The follow up of Göteborg also includes a special set of goals: (e.g.)

- at least 22 % of electricity from renewables by 2010 environmentally friendly transport;
- the new chemicals strategy;
- agricultural policy and ecologically sustainable production methods.

Of high importance is the pointing at a first set of priority areas:

- climate change (“yes” to the Kyoto Protocol);
- transport (combating volume, crowdedness, pollution etc);
- health (in relation to the Chemicals policy; contagious diseases; the food authority);
- natural resources (agricultural- fishing- product- policies).

If we look more in detail into these four items we find.

Climate change

- the Kyoto protocol is important to meet national and European commitments;
- targets for 2010 of electricity from renewable energy sources are set (see above);
- an invitation to the European Investment Bank to address the issue.

Transport

- volumes of traffic and congestion has to be addressed;
- decoupling of transport growth – GDP growth needed;
- road to rail/water/public passenger transport shift is necessary;
- infrastructure investment for SD transport needed;
- better pricing policy of transport to be developed.

Public health

- safety and quality of food to be addressed (e.g. through the establishment of the European Food Authority);
- use of chemicals is of increasing importance (implement the Chemicals policy);
- outbreaks of infections diseases and resistance to antibiotics have to be combated;
- European surveillance and early warning networks should be developed.

Natural resources

- there is a need to change the relationship between
    - economic growth;
    - the consumption of natural resources and;
    - the generation of waste.;
- maintaining biodiversity;
- preserving ecosystems;
- avoiding desertification;
- add objectives to the Common Agricultural policy;
- review the Common Fisheries policy;
- implement the EU Integrated Product Policy.

As we are dealing with the connection to research it is interesting that there is a clear reference to the 6th RTD Framework Programme, especially with regard to the thematic domains:

- energy;
- transport;
- environment.

As a summary of the policy part we can thus say that the EU Sustainable development policy has, as it now stands, the following key features. It

- is multidimensional – systemic in nature;
- emphasises the policy process (including review and feedbacks);
- deals with multilevel governance as essence of the design;
- is consultative and participatory in nature;
- it has not only European but also global connotation;
- it has provided a priority sequence and a set of themes;

The sustainability development research characteristics

What could now be said to be the characteristics of research in support of Sustainable Development? This has been broadly debated and there is no clear consensus at the moment. It would though be fair to say that the following points would fall high on many suggested lists:

- systems features
  - inter-disciplinarity;
  - cross sectors approaches needed;
  - contextual embedding (including the socio-economic frame to make any assessment).
- long term (but also medium term actions);
- multi-scales ("glocality");
- issues of "matches" of different phenomena – e.g. natural phenomena and socio-economic-cultural phenomena at different scales e.g. watershed management;
- items related to "risk"/danger - but also to window of options:
  - several paths;
  - avoid non-sustainable directions;
  - recall path dependence of technology.
- actors presence:
  - upstream presence in the R&D agenda;
  - "practice orientation";
  - also uncommon R&D directions.
- governance embedded.

We could in particular in the research domain point at developments with regard to:

- the increasing level of *integration* in the domain of "global change" research;
- the increased interest in the research community around the *Micro-Macro* connection;
- the increased understanding about the importance of the *Science-Policy* relation;

Integration

The important issues here concern the need to connect still unconnected domains of knowledge:

- weaving disconnected perspectives together;
- developing further the link natural science – social science/humanities;
- further pursuing issues related to systemic complexity (e.g. resilience);

This means R&D challenges relating to the way how to address:

- the full range of multi-disciplinary to trans-disciplinary approaches;
- facing more facets of complexity but in orderly ways thus living up to the various;
- holistic challenges;
- accepting the need to act in parallel to further investigation, and to use the inflow from that practice as an iterative input in the R&D process.

The Micro-Macro connection

Facing globalisation in a world of local existence introduces a number of analytical challenges:

- the move from global level aggregates only to regional (and also more local) understanding as the basis for modelling;
- governance as expressing a multi-layered institutional and political power reality;

- the role of lifestyles of individuals in a world of market sensitivity.

The Science-Policy relation

The two sides indicate a gap, which definitely is there. However, the sustainability themes push the need to find ways and means to bridge the gap, as the bridge is inherent in the sustainability challenge. This means e.g.:

- to understand the differences in the logic of the two sides;
- to appreciate a common task;
- to find practical means and institutional forms to face the challenges;

Tools to approach the linking of SD policy to R&D capacities

What we have seen above is the landscape of two territories: the SD policy territory and that of R&D policy and implementation. How to move to better connect these two? Here we have to discuss various tools to be further developed or even to be invented. I am using the word "tool" in a fairly broad manner dealing with different phases of the R&D work. We need to have tools for:

- avantguard "search" of entries of understanding;
- combining policy domains (e.g. R&D-policy and innovation policy but also investments policy i.e.- "policy combinatorics");
- stakeholder involvement ("participatory involvement in R&D agenda setting");
- creating conditions for R&D activities ("institutional design");
- financial mechanisms;
- implementation mechanisms;
- feedback and synthesis mechanisms in connection to policy;
- "precautionary tasks mechanisms";
- quality control;
- result dissemination.

But different tools have different characteristics:

- the long term characteristics of the issues calls for tools with substantial duration;
- the need for step by step practical experiences calls for investment elements in other things than just research, but with a distinct coupling to the R&D strategy – especially in technology;
- the potential path dependency calls for contextual sensitive parallel approaches combined with comparisons inbuilt in the strategies and readiness for the costs involved in keeping options open;
- the many possible alternative SD end states call for tools being open for value diversity;
- the participatory challenges call for tools that provide agenda definition mechanisms.

We could also frame these considerations in terms of a set of questions:

- What specific requirements emerge due to the "governance" embedding? (i.e. regarding the tools related to the Science-Policy interface);
- What specific demands emerge from the "actor" relevance? (i.e. the tools related to participating mechanisms especially upstream in the definition of the agendas , including the need to balance the roles of the stakeholders involved);
- What specific demands are drawn from the systemic nature of the issues? (e.g. early connections between different of the unconnected domains of knowledge. Specific

mechanisms for this to be designed and encouraged, including inter-disciplinary institutional platforms).

These questions in turn can be connected to the presently discussed suggested institutional tools within the future EU R&D machinery:

- How could the first steps within the ERA be done that still keeps a variable geometry of styles open, but which at the same time makes advances forceful and possible at an as early stage as possible?
- What are the very first steps? Spearheading test cases? Which thematic realms? Through which actors?
- How should the article 169 option be regarded in this context? Is it only to be confined to the 6th Framework Programme domain, or is it broader?
- How should we regard the suggested “tools” in terms of their functional characteristics i.e. in their capacity to provide e.g.:
    - the networks;
    - the financing mechanisms;
    - synthesis mechanisms;
    - evaluation mechanisms.

We also have to take note of the differences between tools with regards to their tasks, the varying thresholds that need to be overcome in order for new activities to take place at all, their time distributions of effects and the depth of their impacts. We also have to take note of the direction in terms of their respective support of a limited European sustainability approach or an approach which – like the Göteborg Summit stress – the involvement of Europe in a global context. The degree to which you stress this broader view has of course implications on the design of the tools you choose to use.

All these items have to be further elaborated upon now when we proceed to discuss research in Europe in support of Sustainable Development, building on all the bits and pieces the European research community already successfully has contributed with and which lies inherent in a wider movement and willingness of the research community to approach these types of challenges.

References

Kates, R.W. et al., Sustainability Science, *Science, Volume 292, Number* 5517 (2001) 641-642

Governance and Sustainable Development

Viewpoint

Angela Liberatore

Directorate General for Research, European Commission (SDME 04/55),
200 Rue de la Loi, B - 1049 Brussels, Belgium
Angela.Liberatore@cec.eu.int

"Governance" and "sustainable development": features

"Governance" and "sustainable development" share a number of features. They are broad concepts with an appearance of "apple pie" -who does not want governance, namely good governance, and a development that is sustainable? - but also involve tensions and conflicts. Both reflect different cultures and experiences, and sometimes are hard to translate in other languages than English in spite of such diversity however these concepts share a global outreach.

And they are not just "concepts". Programmes to promote good governance have been launched at various levels, from local to global or –more often- from global actors and institutions (such as the World Bank) to national and local ones. Agendas, policies and strategies intended to foster sustainable development have decades of history (two if one start counting from the UN Conference on Environment and Development of 1992, or more if one includes earlier "steps" such as the Brundtland report of 1987).

In spite of a wealth of reflection as well as action on ("good") governance and on sustainable development, the interactions between the two need further exploration.
I would like to suggest some reflections –from the viewpoint of someone living and working in Europe- concerning seven main links: enhancing democracy and participation; overcoming "sectoralisation"; managing public goods; tackling distributive aspects; avoiding "short-termism"; articulating levels; sharing knowledge.

Enhancing democracy and participation

Enhancing democracy and participation is not an automatic outcome of debating "governance". For governance to be democratic key issues of accountability and legitimacy need to be addressed. In the European context for example, the debate on governance is closely related to improving civil society participation in policy making, matching this with strong representative institutions, increasing openness, safeguarding plurality of views and interests, and clarifying the "checks and balances" at various levels. All this is relevant for pursuing sustainable development policies; Agenda 21 and Local Agenda 21 already stressed the importance of participation, and the pursuit of economic, social and ecological compatibility requires that all views can be put "on the table" and that decision made can be checked and challenged.

Overcoming "sectoralisation"

Overcoming "sectoralisation" of policies is a basic ingredient for tackling the complexity and interdependence of environmental, economic and social processes. It is also a challenge to current governance modes where sectoral policies, administrative structures and political agendas tend to exclude "cross-cutting" issues from consideration, or prove incapable of handling them if such issues succeed in emerging. Integrating environmental considerations in other policies has been a useful approach introduced in European policy making. The next step is even more ambitious and calls for integrating economic, social and ecological aspects of sustainable development "upstream". Since "integrating everything with everything else" is clearly impossible, defining the key interfaces and priorities is a must. Identifying vulnerabilities –as proposed in the previous issue of the Newsletter- and further developing methods for integrated assessment (a tool under discussion in Europe is "Sustainable Impact Assessment") could help policy integration.

Managing public goods

Managing public goods is another link between governance and sustainable development. Some critics of the notion of "governance" suggest that this is just a façade for "privatisation of government"; the concern is that the increasing influence of the private sector in public decisions may lead to disregard or inappropriate management of public goods –from water to health or education. Even if the definition of "public good" is not to be taken for granted (indeed it is debated within economics and –even more- between economics and other disciplines), it is clear that the ability of governments and of governance structures to guarantee universal access to vital resources is a key element of their effectiveness and legitimacy. It is also important to note that privatisation policies are sometimes a "top down" imposition at odds with sustainable development paths, for example in local contexts where common property arrangements could be more suitable.

Tackling distributive aspects

Tackling distributive aspects is a very "old" problem. Such problem however takes new features when environmental and sustainable development constraints (e.g. ecological carrying capacity, rights of future generations) come into the picture: the possibility to simply "expand the cake" –e.g. uncontrolled use of natural resources, postponement of decision (e.g. on pension schemes) to later generations- is not feasible. Equitably sharing "the cake" becomes then an issue that cannot be shifted nor postponed and that involves important governance issues, e.g. the balanced representation of interests within and between countries, the identification of instruments to allocate resources, the assessment of economic, social as well as environmental costs. In a trans-national context such as the European Union, distributive aspects between countries, within countries (e.g. disadvantaged regions) and sectors (e.g. agriculture) are being reassessed in light of enlargement, globalisation as well as sustainable development considerations.

Avoiding "short-termism"

Avoiding "short-termism" in policy making is a key challenge for governance. Not only electoral cycles but also investment cycles (which are crucial when deciding on issues such as infrastructures) tend to be too short to deal with long-term changes and to take care of future generations –as sustainable development principles prescribe. Again, this seems a specifically tough challenge for democratic governance where "constituencies" are present citizens/electors and decisions are made to respond to interests that find a "voice" in the political and economic sphere. Provisions for foresight and longer-term planning are being explored in debates on governance, in Europe and elsewhere; however the rights of future generations are still difficult to formalise (for example, the European Charter of Fundamental Right adopted in December 2000 does not include these).

Articulating levels

Articulating levels is an obvious but still difficult task in the context of "multi-level governance", which spans from local to global. The tendency is to stick to "clear", often rigid, definition of competencies at the expenses of working out the interfaces and synergies. Lessons from the environmental movement motto "think globally, act locally" (and vice-versa) are still to become part of new governance arrangements. Articulation of levels is a key issue in settings like the European Union where the principle of "subsidiarity" is at the core of policy debate and implementation.

Sharing knowledge

Sharing knowledge is the last, but surely not least, of this incomplete set of linkages between governance and sustainable development. The development and use of knowledge and "expertise" is a key feature of governance, as many complex issues need to be tackled that require scientific as well as practical knowledge. Expertise itself needs to be "democratised" to contribute to public debate and decision making. This is especially the case when –as in many sustainable development issues- "minority views" may prove more accurate in anticipating risks or where local and indigenous knowledge are crucial to the identification of both problems and solutions. "Democratising expertise" is one of the venues being explored in the European Commission"s debate on governance and is a challenge to be shared with all those interested in sustainable development.

References

This text was first published in "IHDP Newsletter: www.ihdp.org" (2001)

Identifying Research in support of Sustainable Development

From Bonn – via Brussels – to Seville

P. Sørup

Head of Technologies for Sustainable Development Unit

European Commission – Joint Research Centre
IPTS - Institute for Prospective Technological Studies
Edificio World Trade Centre - c/Inca Garcilaso s/n
E – 41092 Sevilla - Spain
Per.Sørup@jrc.es

Introduction

The Institute for Prospective Technological Studies is one of the seven institutes composing the European Commission's Joint Research Centre (JRC). The mission of the JRC is to provide customer-driven scientific and technical support for the conception, development, implementation, and monitoring of the EU policies. As a service of the European Commission, the JRC functions as a centre of science and technology reference for the European Union.

Close to the policy-making process, it serves the common interest of the Member States while being independent of special interests, private or national. JRC objectives for 2002 include playing a key role in the European Research Area, taking into account the capacities of its institutes in providing reference systems, networking and mobility of scientific skills.

Established in 1994, the IPTS' mission focuses on providing scientific support to European policy-making. The IPTS anticipates, monitors and analyses developments in science and technology, their cross-sectoral impacts, their interrelationships in the socio-economic context and future policy implications. Emphasis is placed on the complex interaction between technology, economy, the environment and society as well as on understanding the dynamic forces that drive and shape change and their relationship with the policy process.

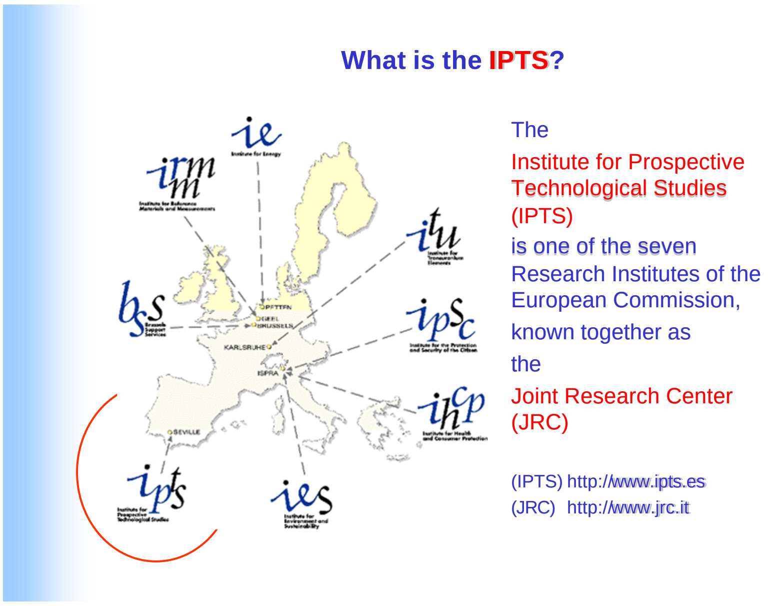


Figure 1. The IPTS in the structure of the Joint Research Centre

In addition to its own resources, the IPTS operates a network of 45 European research institutes working on related issues, the European Science & Technology Observatory (ESTO). Selected ESTO partners are presently carrying out a mapping exercise on national research programmes supporting sustainable development, identifying relevant actors and areas of activity.

The preliminary outcomes of the survey are being presented at the Workshop in Brussels.

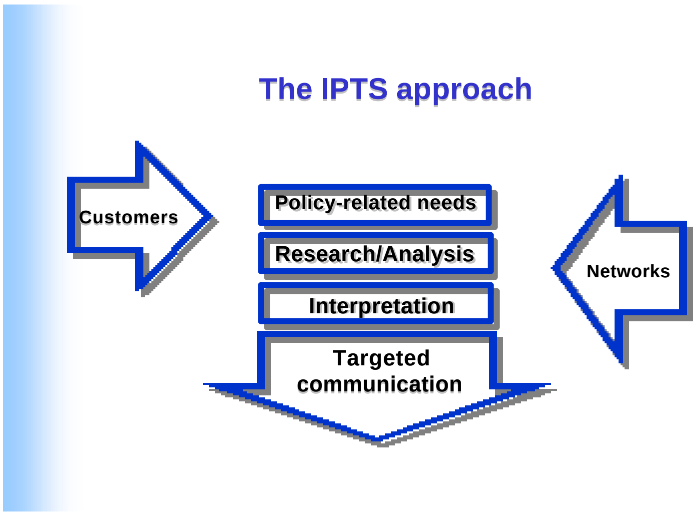


Figure 2. The IPTS Approach

R&D supporting the European Union Strategy for Sustainable Development

It is worthwhile highlighting the main milestones that have characterised the process leading the European Union to being the first international organisation having a common, continent-wide strategy for sustainable development in May 2001. It is interesting to highlight that research has constantly supported the policy-making process

R&D in support of the European Union Strategy for Sustainable Development: Milestones

- **Cardiff EU Council Conclusion (06/1998)**
  - Integration of Environment into community policy
- **Lisbon EU Council Conclusion (03/2000)**
  - Employment, competitiveness and social welfare
  - Knowledge-driven economy
- **Gothenburg EU Council Conclusion (05/2001)**
  - Link to social and economic areas (Lisbon)
  - Identified Priority Sectors:
    - Climate change and clean energy
    - Public Health
    - Natural Resources
    - Transport and land-use
- **Amsterdam Workshop**
- **Bonn Workshop (1-2 Feb. 2001)**
  - R&D policy as key driver in design and implementation
  - Indicators, monitoring and assessment tools
  - Criteria for the evaluation of project proposals labeled as 'sustainable'
- **Bridging the gap (9-11 May 2001)**
  - Sustainability a trademark for the ERA
  - Need of multidisciplinary and long term research
- **Brussels workshop 28-29 Nov. 2001**
  - Tools
- **Sevilla workshop (April 2002)**

Figure 3. Milestones leading to the EU Strategy for Sustainable Development and parallel support activities

Indeed, the series of workshops initiated in Bonn on 1-2 February 2001 led to the preliminary conclusion that research policy is to be considered as a key driver. It proves of paramount importance in supporting the design and implementation of sustainable products and services, while at the same time developing three-dimensional sustainability assessment tools, so as to be able to identify criteria for evaluating projects as well as assessing progress.

When tackling the support provided by research and development to the EU Sustainable Development Strategy, it is crucial to take into account the specific characteristics defining this relationship. Indeed, it seems that three characteristics are worth being analysed in depth.

First, in the case of the support provided by research towards progressing in the direction of sustainable development, we are looking at "systemic research", aimed at supporting the identification of "useful" policies to stimulate balanced developments, and to disentangle problems while improving democracy.

Secondly, research supporting sustainable development is characterised as being "problem-solving". In line with the priority areas identified by the EU Strategy for Sustainable Development and maintaining the three-dimensional approach of sustainability, research support needs to focus on improving our knowledge and understanding of facts and their interrelationships, on avoiding crises and on improving existing or designing bran new ways for tackling the problems identified in each priority area.

Third, considering the new, multi-dimensional character of sustainable development, research support should focus on the development of tools, which can be classified as belonging to two groups: tools for sustainable development policies, and tools for research policies supporting sustainable development. In the former, the focus will be on the development of policy instruments, on indicators, and assessment tools working as decision-support systems. In the latter, the focus will rather be on the conception of appropriate R&D programmes, which can be considered as being supportive of sustainable development. In this case, it is therefore crucial to define some "how to", including "How to prioritise", "How to identify criteria to select appropriate projects", "How to assess the impacts of chosen R&D programmes".

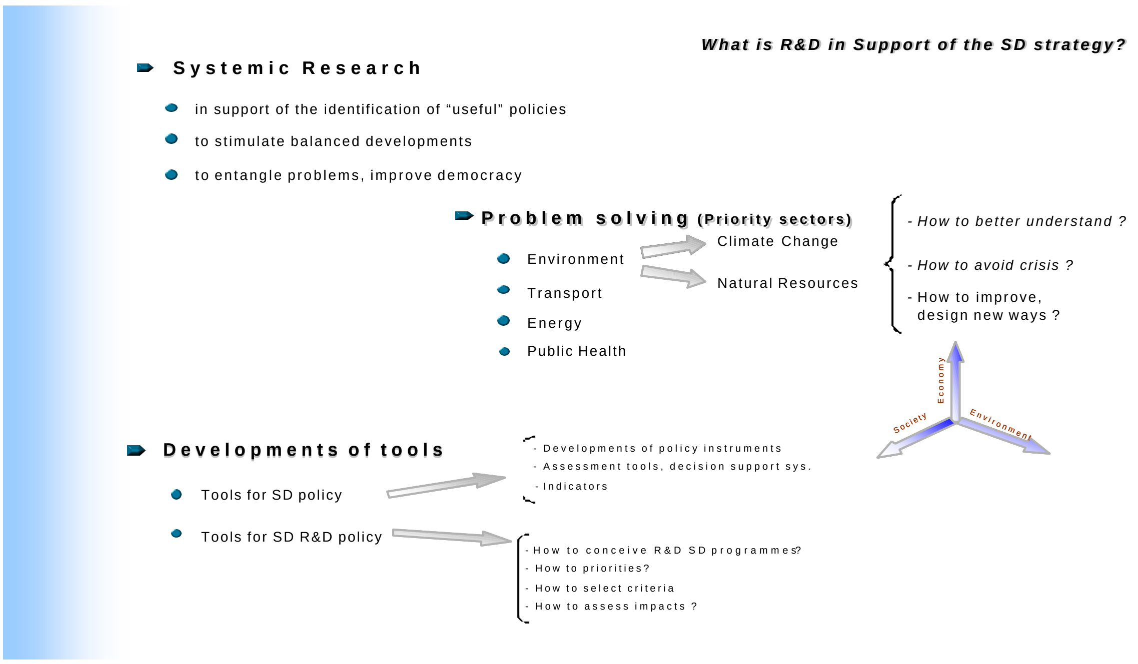


Figure 4. Characteristics of R&D supporting EU Strategy for Sustainable Development

Relevant on-going activities at the IPTS of the European Commission's Joint Research Centre

The Institute for Prospective Technological Studies of the European Commission's Joint Research Centre has been involved from the early steps of the EU Sustainable Development Strategy and this activity keeps on being among its priorities. Currently, a range of on-going activities ensures that the IPTS can provide state-of-the-art advice on research and R&D programmes supporting sustainable development in Europe.

The IPTS has launched the mapping of national sustainable development research activities and in that of key actors in each country, which support national and EU sustainable development policies. This exercise is carried out by the IPTS via the ESTO (European Science and technology Observatory) and the preliminary results are being disclosed at the workshop in Brussels. The project will be finalised in 2002 and final results will be presented in a workshop in Seville in the spring.

The IPTS has developed integrated assessment tools jointly with DG Enterprise, the IA^{PLUS} and IA^{STAR} tools aiming at providing Commission services with a valid instrument to facilitate decision-making integrating the three dimensions of sustainability.

The IPTS is participating in networking activities such as the accompanying measure funded by the 5th RTD Framework Programme AIRP-SD (Adaptive Integration of Research and Policy for Sustainable Development). The 18-month activity is starting in January 2002 and has as its prime objective the strengthening of capacities of RTD processes to contribute to sustainable development by stimulating innovation in RTD process which are likely to enhance the sustainability of production and consumption systems.

The IPTS has set up a website entirely dedicated to sustainability issues: http://sdie.jrc.es. The site offers relevant information on EU and national Sustainable Development policies, Sustainable development research, sector-relevant research, integrated assessment tools, proceedings of conferences dealing with the topic of Sustainable Development, and so on. The website, which is designed to maximise user-friendliness, also provides a virtual platform for discussion for those working in this field of research. It will be on-line as of beginning of January and you are most welcome to visit it and to send your comments and suggestions.

As mentioned above with regard to the mapping exercise, the IPTS will host an event in the Spring of 2002, as the third workshop in the series initiated in Bonn in February 2001 and followed by this workshop in Brussels in November. Despite the fact that the specific contents of the workshop will be partially defined depending on the interests expressed at the workshop in Brussels, it is thought to focus primarily on:

- Presenting, discussing and validating the final results of the mapping exercise on national research policy experiences and key actors in support of sustainable development to analyse success stories and shared research needs;
- Analysing EU priority areas in terms of monitoring and assessment requirements, integrated research activities, and best practices specifically focused on the implementation of the EU strategy for Sustainable development, and;
- Holding a targeted discussion on the most suitable instruments for national R&D programmes and identified specific actions benefiting from a common approach to launch collaborative actions for the initial phase of the 6th RTD Framework Programme.

Additional information on this upcoming event will be posted on the http://sdie.jrc.es website in the coming weeks and you will receive a first announcement and draft agenda at the beginning of January 2002.

Conclusions

To conclude this introductory presentation on behalf of the IPTS, I would like to briefly summarise the key characteristics of research support to sustainable development, namely:

- Systemic research
- Problem-solving research
- Research aimed at developing appropriate integrated assessment tools

With regard to the latter, it is important to distinguish between tools in support of Sustainable Development policies and tools aimed at R&D policies in support of Sustainable Development.

The IPTS has a sound expertise on the multi-disciplinary approach intrinsic in Sustainable Development and has been involved in the definition of the EU Strategy for Sustainable Development since its early steps. Additionally, it has enjoyed sharing and building its experiences with Member States' institutions via ESTO projects and the workshops specifically dedicated to R&D policy in support of Sustainable Development initiated in Bonn and followed by the Brussels workshop. That is why it is fully intentioned to develop this successful experience further in Seville in spring 2002.

I would like to thank the organisers of the Brussels workshop as well as my collaborators, Mr Luís Delgado, Mr Fabio Leone, Mrs Laura Lonza, and Ms Laura Tapias in the IPTS' TSD Unit.

"Acquis" under the EU research Framework Programme in the context of the Göteborg conclusions

Pierre Valette

Head of Unit

Directorate General for Research, European Commission
200 Rue de la Loi, B - 1049 Brussels, Belgium
Pierre.Valette@cec.eu.int

Two questions

- What is the "state-of-the-art" of the Sustainable Development research activity in the EESD Programme?
  - Generic activity and accompanying measures
  - Key actions
- What is the usefulness of the outcome of this research in the context of the Göteborg strategy and what are the necessary orientations?

"Acquis"

Four categories of projects in ESD:

- Social, institutional, organisational, governance aspects of S.D.
  FP IV - 46 projects on 61/FP V - 7 projects on 13

- Economic analysis and development of tools (mainly models) or accounting frameworks and indicators
  FP IV - 12 projects on 61(4 for tools)/FP V - 5 projects on 13 (3 for tools)
- Natural science dedicated to Sustainable Development issue
  FP IV - 3 projects on 61/FP V - 1 project on 13
- Sustainable management systems and technologies
  FP IV - not appropriate (in K.A.)

Overall picture

- Climate Change issue as a "model" for the treatment of the different aspects of Sustainable Development; natural science thresholds and impacts, economics, social aspects, instruments and technologies.; both in ESD and Energy
- Regional organisation and social aspects for Sustainable Development: driving force in ESD; tools and quantitative economic assessment (E3 models, scenarios);driving force in Energy; increasing activity in ESD
- Sustainability is present in the key actions "City of Tomorrow", "Water Management", "Marine and Coastal Management" and includes impact assessment and risk analysis, management systems.
- Sustainable Energy technologies (incl. technologies for Transport) are present in the key actions of Energy
- Sustainable and environment technologies are developed in the Growth Programme. Sustainable Development Criteria are a driving force for the choice of new technologies to be developed: clean industrial processes, eco-design, waste management, End and Life products.
-

"Göteborg" requests

Economic and social

- "Getting prices right"; reflecting true cost to society "… Ensure that by 2004, price of using modes of transport better reflects costs to society"
- "Sustainable Impact Assessment" covering potential economic, environmental and social consequences
- "How environment technology can promote growth and employment"
- "Headline indicators for the evaluation of Sustainable Development implementation"

Natural science

- "Targeting environmental priorities"
- Climate Change : "emissions of GHG from human activity are contributing to global warming"
- Sustainable transport: "costs to society" (health & environment)
- Threats to public health: "chemicals only produced in ways without significant impact on health and environment."
- Managing natural resources : "sustainable use of natural resources and levels of waste", "IPP for reducing resource use and environmental impact"; "emphasis on environmentally sustainable production methods" (CAP)

External dimension of Sustainable Development

- Global environmental governance
- Trade and environment policies mutually supportive
- "Global deal" on Sustainable Development at Johannesburg

"Gap"

According the "Göteborg" priorities, policy makers are waiting urgently from research background information and transparent methodologies on scientific and economic dimensions of S.D., integrating social aspects.

Priority needs are:

- Methodology for Sustainability Impact Assessment: economic tools, both micro and macro, cost-benefit analysis and quantitative valuation of indicators or criteria (ex. NEMESIS, GEM E3, POLES models).
- Accounting framework of externalities (cost of environmental and health impacts of technologies) according the "Göteborg priorities" (ex. ExternE, GREENSENSE).
- Thresholds of sustainability, impact assessment and forecast (ex. nutrients).
- Cost-efficiency analysis against thresholds (ex. Climate Change prevention).
- External dimension of ESD e.g. "capacity building".

"Bridging the gap"

- 6th FP will provide important means for research in the areas identified above.
- ERA, in particular Science-Society, will provide opportunities for a better interface with stakeholders and policy-makers, for a better dissemination of results.
- EU Strategy for Sustainable Development will provide consistency between policies and will exploit research results… if available on time.

But

- The research which has still to be made should be common ("a common approach for a common issue").
- Member States, Accession countries and EU have to work together on the same basis in terms of tools, definitions, methods, data; international comparisons should be made feasible.
- They have to "share their analysis" for the same sustainability objectives and exchange their best practices.

Article 169 focused on the "Gap" issues should help to design and implement a joint national and EU programme for sustainable development research.

National research activities and Sustainable Development. An ESTO survey and assessment of national research initiatives in support of Sustainable Development.

Katy Whitelegg & Matthias Weber

ARC Seibersdorf research GmbH,
2444 Seibersdorf – Austria
matthias.weber@arcs.ac.at

Introduction

This paper provides a first overview of a study on identifying and assessing national research activities on sustainable development (SD) that was set up through the ESTO network[2] following the workshop "Setting Concepts in motion: Sustainable Development and R&D policies" in Bonn in February 2001 in order to pursue the aim of understanding the contribution of research to implementing SD and to provide a more solid foundation for developing an approach to a better co-ordination and co-operation among national and European research activities in this area.

Providing an overview and assessment of national research activities on sustainable development contributes to increasing the understanding of the role R&D activities can play in implementing SD and in particular to developing solutions to the six key threats to SD laid out in the recent European Commission communication to the European Council in Gothenburg. Although R&D is expected to play an important role in addressing the unsustainable trends outlined in the communication, the multi-dimensional nature of SD poses considerable challenges for the design and implementation of research activities.

An overview of national research activities also contributes to the current debate on developing better co-ordination and co-operation of research activities on SD through forming a base for initiating activities as a part of the European Research Area. Increased co-ordination would facilitate the exchange of best practise examples and allow gaps in research activities to be identified and addressed. Several mechanisms are already being developed as part of the Sixth Framework Programme proposals that promise to enable a better co-ordination of national and European research activities.

Rather than a comprehensive and detailed survey of all Member States and Pre-Accession countries, the study represents a pilot exercise from which to draw first preliminary conclusions. A total of seven countries were selected that cover a reasonably wide variety of national research programmes and systems. Neither does the survey cover all research that is conducted on SD issues, but only selected segments of particular European relevance.

The conclusions drawn here are furthermore based on a synthesis of the interim reports and are not a complete overview of the research, which began in August 2001. An assessment of all research programmes identified in the study will be available on completion of the project in February 2002.

Concretely, this paper outlines the objectives of the study and details the steps taken to identify and analyse national programmes in support of SD. It explains the approach adopted for initially selecting the programmes and subsequently the method used for assessing the individual programmes approach to addressing sustainability and in particular their ability to address the multi-dimensional nature of sustainability and include more than one of its key dimensions (environmental, economic and social).

First preliminary results of the study are given that point to a number of different types of programmes that have been identified across the seven countries. Moreover, the paper also looks in more detail at the national research context and at the organisation of research activities in support of SD and how these influences the research activities. This allows finally drawing some preliminary conclusions with respect to the difficulties with which the envisaged tighter co-operation between research activities in Europe is likely to be confronted.

[2] ESTO is the European Science and Technology Observatory network, a network of research organisations in Europe, set up by the JRC-IPTS.

Project tasks and implementation

The study aims to map the key national actors involved in SD and identify and assess the national research programmes in support of SD in selected thematic areas in seven European countries: Austria, Belgium, Germany, Holland, Portugal, Sweden and the UK. The study focuses on programmes specifically targeted towards SD and programmes addressing three selected problem areas: threats to public health, loss of biodiversity and transport. The reason for selecting the latter three consists of the fact that they figure prominently in the Gothenburg communication as key threats to SD.

The focus is on programmes that are currently running, however, the timeframe included in the study was left flexible so as to include any significant changes in policy for research in support of SD that have occurred recently or that are currently underway but will not take effect until the next programme period is implemented.

The project is organised into three main work packages:

- mapping the key actors involved in research in support of SD,
- identifying the national research programmes in the four areas mentioned above and
- assessing the research programmes ability to address the three pillars of SD.

The third work package also includes the development of a set of framework guidelines for the assessment of the research programmes. This assessment focuses on the extent to which the programmes are able to integrate different aspects of SD. Assessing the integration has been a research issue for many years but is still an unresolved problem. We looked at to what extent and in what detail the integration of the three pillars can take place. This applies to two levels, namely thematically through examining the issues under consideration and in process terms through looking at the framework of the way in which the programmes are organised to ensure integration.

In order to ensure coherent results across the seven countries under study, a set of common guidelines was formulated for the three work packages. Following these guidelines, the three main work packages were researched simultaneously, initially through desk research to identify a first list of programmes and individuals to be contacted and then through interviews with the programme manager and discussions with researchers and other individuals involved in research activities in support of SD.

Mapping the actors

Mapping of the key actors contributes to an understanding of how research activities are organised and which actors are responsible for designing and implementing research in support of SD. In total we looked at the following seven categories of actors:

- policy making: ministries, parliamentary committees;
- funding bodies: public, semi-public, private;
- research organisation: universities, public sector research activities/ non-university research organisations, private research organisations/consulting, industrial participants (criteria: do they get public funding?);
- advisory boards: general political level, scientific community level;
- networks: (could be about solid and fixed networks or about more links);
- civil society: NGOs, science shops;
- others.

This exercise was intended as a base for exploring future co-operation in this area. It looked at the extent of actors involved in developing and implementing research on SD and attempted to outline the role the different actors play and assess which actors play key roles in setting the research agenda for SD and how implementation is organised. We looked at who is responsible for developing research policy on SD and which types of organisations are involved in carrying out research activities. We looked at whether new structures have been established to oversee research on SD (such as e.g. in Sweden where there are new structures have put into place in the shape of research councils or programmes) or whether there are attempts to link different disciplines and departments to better organise research and policy on SD (such as attempts in the UK to form a network on research on SD in order to allow policy makers better access to research in support of SD and to assess where the gaps in research for SD are in the UK).

Selection of research programmes

Research in support of SD could in principle include a wide range of research activities; however, for the purpose of this study we focus on two areas of research activity, targeted programmes and three selected sectoral areas.

Each country participating in the study performs research activities specifically targeted towards SD. These often include relatively new and innovative ways of looking at research problems and of seeking solutions. In addition to mapping the number of programmes and their thematic focus, we were able to examine in more detail the way in which the partner countries organise their targeted programmes including the different national definitions of sustainability and the varying degree of commitment shown in putting these into practise.

The second area of research activity under examination, the three sectoral areas, threats to public health, loss of bio-diversity and transport congestion, are areas of research activity where the main focus of research is often not SD and where the research programmes identified often do not even mention SD. However, as mentioned above, these areas represent key threats to SD and it is therefore essential to include an analysis of these areas in a study on research programmes in support of SD.

The three areas were selected on the basis of the Commission's Gothenburg communication outlining the key threats to SD in Europe. Although the communication defines six key threats, the study concentrates on three of the six threats, namely on those that promise to provide major insights with respect to our core issue, i.e. the integration of the three pillars. The aim of analysing the programmes that focus on these threats allows an overview of research activities addressing the key threats and a first attempt at assessing how research activities in these areas are integrating the aims of SD.

Assessment of research programmes

The guidelines for assessing the integration of the three pillars of SD into national research programmes comprised a two-stage process looking at the programmes in terms of thematic content and in process terms.

The first step of the assessment process is based on examining the thematic content of the programmes or, in other words, the concrete issues, which the programme addresses. Using a detailed list of issues (Table 1) as a check list that broke down the three environmental, social and economic pillars of SD into concrete issues, we were able to assess whether a programme was cable of addressing issues contained in more than one of the pillars or whether the programme focused on issues contained in a single pillar.

The list of issues used as a breakdown of the three pillars builds on the results of a previous ESTO project, IA STAR "A Methodology for Appraising the Sustainability Implications of EC initiatives". The results of this project proved to be a useful starting point for developing an assessment of research programmes as the project developed a breakdown of what is meant by SD in the three different areas to be used in developing an appraisal mechanism for assessing Commission policy initiatives.

Based on: IAstar Report "A Methodology for Appraising the Sustainability Implications of EC initiatives - The Integration of Economic, Societal and Environmental Aspects" ESTO-Project

The check list was designed to be used as a guideline for assessing the scope of the content of the programmes and as a basis for assessing the extent to which they address more than one pillar so as to provide an overview of the extent to which programmes in support of SD integrate different aspects of sustainability. The assessment exercise is intended as a preliminary overview. The checklist should therefore not be seen as a full-scale method for screening and evaluating programmes as this was not within the scope of this study.

The second step for the assessment was based on process orientated criteria. The list of criteria used in this section has been drawn up on the basis of recent discussions on the changing requirements that research in support of SD demands.

A set of questions was designed to examine the way in which selected criteria for achieving SD are integrated into the design, the organisation and the implementation of research programmes. The following criteria were included in the analysis:

- To look at what timeframe was used. To see whether several different time frames are included into one programme with different measures adopted for looking at short, medium and long term solutions.
- The scope of the programme. Whether the programme is able to consider different levels local, regional and global.
- Given the multi-dimensional nature of SD, the extent to which the programme is inter-disciplinary and includes aspects such as the relationships between societal actors and the research world.
- The range of stakeholders involved in designing and in implementing the programmes.

The final question addressed the radical nature of the research programme. If sustainability means a radical shift, how is this achieved in the research process? We looked at how radical the programmes were and to what extent they were suggesting continuing along current paths or to what extent the programmes promoted radical change.

We also looked at whether there was a difference between programmes that seek new solutions to address the main threats for SD, as detailed before and programmes that seek to address the entire framework in which certain processes take place. The latter entails bringing about regime shifts: either architectural, social or technological that are necessary for achieving SD.

Main types of programmes

The preliminary overview of the identified research programmes revealed that not only there area wide range of ways of organising programmes in support of sustainable development, but other factors such as the organisation of the research system or EU policies (including other than research policies) also play a considerable role in influencing research activities for SD. Although programmes are an important method for supporting research activities, they do not reveal the entire picture. However, the overview of the types of research programmes below provides a typology of the types of research activities carried out in support of SD on the national level.

The initial phase of the project identified 72 research programmes in six countries[3] showed in the Table 2 below.

[3] Holland was not included in the initial phase as the identification of Dutch research programmes had not been completed. The Dutch case study will, however, be included in the final report.

Table 1 Issues For the Sustainability Appraisal of National Policy Initiatives		
Environment	Social	Economic
Renewable Resources (forests and biomass, agricultural soils and areas, fish stocks, fresh water resources such as surface waters, groundwater and fossil waters, as well as biodiversity and genetic resources - use rate should not exceed the rate of their regeneration)	Public Health	Human Capital Formation and Employment
Non-renewable Resources (maintain the use range of non-renewable resources, such as fossil energy resources, minerals and metals)	Education	Innovation (increasing the ability of EU firms and institutions to generate and utilise new knowledge, to introduce and diffuse new saleable products and services, as well as, improve existing ones)
Regeneration Capacity of the Atmosphere	Liveable Communities	International Performance
Carrying Capacity of Water and Soils	Equality of Opportunity and Entitlement	Market Structure (general frame-work for economic activity, conditioning the behaviour of economic agents and their performances)
Waste Production	Culture	Economic and Social Cohesion
Risks with Potentially Catastrophic Consequences	International Co-operation	Market Mechanisms (creating the normative and regulatory conditions for the improvement of market efficiency; facilitating the movement and efficient allocation of production factors; favouring fair and free competition both within the Union and with economies outside the Union)
Landscape (landscapes of individual character and beauty and the cultural heritage should be protected)		Income Growth (to generate and self-finance a balanced and stable increase of wealth, with a permanent attention to the maintenance of free and open market competition)
Environmental Health		Price Level and Stability
Environmental Information and Management Systems		

Table 2 National Research Programmes identified per Country		
Country	No. of Programmes	Comments
Austria	6	
Belgium	3	3 national umbrella programmes, 2 regional programmes, 17 sub-programmes
Germany	10	Number does not include programmes on loss of biodiversity as too numerous to include in the scope of this study
Portugal	16	Relevant to the study, but not national research programmes
Sweden	4	4 umbrella, over 20 sub-programmes
UK	33	

One way of categorising the programmes and of gaining a better understanding of the types of programmes that exist was to group them according to the different objectives and approaches adopted for addressing SD. We identified five categories ranging from technology-oriented approaches to more integrative, systems-based programmes. The list of programme categories outlined below is not a comparative survey of all the programmes identified but a preliminary overview of analysis based on interim reports.

Integrative programmes

A proportion of the programmes identified reveal a trend towards developing new and different approaches to the design and organisation of research activities in support of SD. These programmes concentrate on examining ways of engaging change in the complex relationship between society and the environment and in doing so progressing beyond merely understanding the relationship. The development of such programmes often requires a restructuring of the whole research process to include a wider range of disciplines and ensure the research engages a broader range of stakeholders in order to focus on a specific interaction where there is a need for change.

Although several methods exist, especially for wider participation of actors and on increasing the inter-disciplinarity of research projects, these remain bolt-on additions in many countries as the framework of the research systems analysed during this project favours more traditional forms of organising research activities. The new types of “integrative programmes” attempt to break down some of the barriers inherent in the research system to include more radical and less mainstream activities and allow new research activities to take place with actors who have the potential to understand and change the problem.

Programmes of this type move beyond a focus on resource reduction through the development of new environmentally friendly technologies, accepting that unless behavioural patterns are not also included and changed then resource reduction alone will not suffice towards contributing to a more sustainable way of life. Examples of this type of research activity in support of SD are the German *Socio-Ecological Research-SERP* (established 1999) and *Regional Sustainability Programmes* (1999-2002). The SERP programme aims to improve the knowledge base on the relationship between humans and their ecological and social environment. It applies a new approach to organising research for SD through the integration of social and cultural goals in environmental policy. The programme aims at the involvement of new actors in the projects, taking users and practitioners on board. Projects on sustainable consumption, for example, have to include all actors involved from the producer, and the retailer to the consumer. The continuous assessment of the programme and the thematic focus is constantly adjusted to include new areas of key importance. The focus of the programme initially is on sustainable consumption, supply services and political strategies for global environmental problems

The UK Programme *Towards a Sustainable Urban Environment* (2002-2006) is another example that attempts to identify and implement radical new solutions for a major reduction of natural resources and energy use through the design of products, processes and the urban infrastructure as a whole. The programme treats the urban environment as a holistic system and therefore aims to involve a variety of disciplines, a combination of research excellence and understanding of diverse user base and research consortia with a mix of academic and non-academic participants.

The Austrian *Cultural Landscape Programme* (1992-2004) is another programme that falls into this category. This Programme aims to implement SD on a regional level, involving a wide variety of actors required to develop options and implement such a long-term and complex process. Cultural Landscape research has three main aims: research for the regional safeguarding of long term economic, social and cultural development, research for ecological and social stability and research for a sustainable relationship between man and nature.

Technology-orientated programmes

The main focus of research programmes in this category is on new technologies. However, the category is relatively broad and the programmes focus on a variety of different mechanisms for achieving the development and diffusion of new technologies.

Many programmes in this bracket focus on technical improvements of products and production processes and therefore on encouraging the development and the diffusion of new technologies in industry. This is the case with the *UK Sustainable Technologies Initiative* that supports non end-of-pipe and clean-up development and adoption of sustainable technologies. It focuses on use of raw materials, waste production, resource efficiency through redesign or substitution and recycling aiming for progressing towards a factor 4 reduction. Another good example in this category is the Austrian Programme on *Technology and Sustainable Development* (1994-2004) that is divided into two thematic sub-programmes *Buildings of Tomorrow* and *Factory of Tomorrow*.

The category also includes programmes that have a thematic focus and were identified as concentrating on one of the key threats to SD. They focus on the development of new technologies for a specific sector like the Austrian *MOVE* programme on mobility and transport technologies or the UK's *Foresight Vehicle Link Programme* (1997-) and *LINK Future Integrated Transport (FIT)* Programme (1999-2002). Although SD is not the main element, the programme addresses one of the key threats.

This category focuses on programmes that have new technologies or innovation processes as their main component. This does not, however, entail that a proportion of the programmes did not look at the broader context in which technologies develop and at ways of changing this framework. Such programmes are almost a hybrid between integrative programmes and technology orientated programmes. They focus on the need to find new models of innovation and therefore also include the necessity of understanding and influencing the relationship between the various parts of the innovation system, the product, the process, the environment and economic behaviour. An example of this type of programme is the German *Framework for Innovations towards a Sustainable Economic Behaviour* (2001-2002).

Programmes in support of „soft" measures

The programmes in this category mainly focus on planning and management issues and look at questions concerning the tools and mechanisms that can facilitate change towards SD such as tax instruments, life cycle analysis, voluntary instruments.

The Belgium sub-programme *Levers for a Sustainable Development Policy*, part of the umbrella programme *Scientific Support Plan for a Sustainable Development Policy* (1996-2002) is an example that combines many planning and management issues in a single programme. It aims at contributing to decision-making and operationalising SD through the development of tools and instruments to implement SD and through the development of indicators for gathering statistical information.

Programmes aiming at development of criteria and monitoring tools

This category is closely related to the previous category and as can be seen with the Belgium sub-programme on *Levers for a Sustainable Development Policy*, the development of criteria and monitoring tools often goes hand in hand with the development of tools and mechanisms for implementing change. Another similar example that seeks to improve the evidence base to support policies on SD is the UK *Environmental Strategy Research Programme* that focuses on the development of indicators and data collection for monitoring progress on SD. It also looks at the effectiveness of a wide range of instruments and tools at a number of different level from the individual firm to local authorities.

Programmes dealing with the relationship between humans and the environment

This fifth category includes those programmes that aim at a better understanding of the relationship between humans and the environment. There are a number of different types of programme that fit into this category some with a more specific environmental focus and others that take a wider approach.

Every country involved in the study has programmes that support the development of policies towards understanding and regulating the effects of human activities on the environment and on health. Many of the programmes that were identified as addressing the key threats to SD in the areas loss of biodiversity and public health fall into this category. These programmes address issues such as water pollution, air pollution, soil, radioactive substances, and chemicals to name but a few and generally put the environmental, or health aspect at the centre of the research question focused on. That is to say, they focus to a lesser extent on changing the practises causing the problem but focus on minimising and achieving acceptable levels of pollution through regulation. Although many programmes of this type were identified, a useful example is the UK *Chemicals and Biotechnology Research Programme* as it uses scientific knowledge on exposure to endocrine disrupters and on the effects of the release of GMOs to support policy making and addresses one of the key factors of programmes in this area, risk analysis. Risk is also a key topic of the Swedish *Environmental Research Council* Programme (2001-2001).

Another set of programmes in this category address SD from more than one dimension (social, economic, and environmental), however, the main difference between this set of programmes and the first category of integrative programmes is the mechanisms through which the research is conducted. The majority of the programmes in this category focus on the requirements for change but do not get involved in how this should take place.

Organising research for SD

Although the main focus of the study is to identify and assess national research programmes in support of SD, it is evident that the context, the national research system, plays an important role in defining research activities on SD. In some countries focusing on the programme level does not, in any way, offer a complete picture of the research activities in support of SD. As a complete analysis of all national research activities was not possible within the scope of this study, only the main characteristics that influence the organisation of research for SD are addressed here. It was not possible to go into detail on the content and organisation of non-programme-based research activities. The national research context is relevant to the organisation of SD research activities in all countries but with reference to this study of particular relevance for Austria and Portugal.

On one level it was possible to identify two types of research system regarding the way in which research for SD is organised, those countries that have strong thematic programmes and those countries that rely on non-targeted sources of funding for research on SD. Five of the countries involved in the study, Germany; Belgium, Holland, Sweden and the UK have research systems that fund a significant part of their research budget through programmes. All of these countries have strong thematic programmes both in targeted and sectoral research activities. Austria and Portugal portray very different frameworks for research funding from the others and also from each other. They mainly fund research on SD through other means apart from programme funding.

Although Austria has a few well known and successful programmes, both targeted and sectoral, and the trend towards programme funding is increasing, a high level of funding for SD is supported through generic sources. The initiative for developing research activities in support of SD is placed on the individual researcher or research institute. This makes it considerably more difficult to produce an overall picture of all national research activities in support of SD in Austria.

The development and funding of research activities for SD in Portugal follows a different pattern. There are no research programmes that are specifically targeted towards SD as the national research programme is relatively small and concentrates on competence building measures. There is, however, a considerable amount of research activity taking place as part of the structural and cohesion fund programmes. One task of the study is to analyse the activities taking place in these programmes and to focus less on national research programmes.

In the other five countries where strong thematic programmes exist, they also do not represent the only source of funding for SD research. Each country has other sources of funding that, although not specifically targeted towards SD, also fund research activities in this area. In the UK, for example, foundations and trusts also fund public research, the Joseph Rowntree Foundation being of particular interest for research on SD as it funds research on exploring the causes of social difficulties. Their budget of 15 million Euro per annum currently focuses on attitudinal studies (vis-à-vis transport and the environment), lessons from grass roots initiatives, local governance processes and a toolkit for localities to maintain the sustainability of their suburbs.

In Germany, research activities are organised in such a way that just under half of the research budget is assigned to institutional funding not programme support. In order to assess the extent of the research activities in support of SD it would be necessary to examine the individual research agendas of the various research organisations including the Deutsche Forschungs Gemeinschaft, the Frauenhofer Gesellschaft and the Max Planck Gesellschaft.

Conclusions

The preliminary analysis reveals the variety of programmes and methods for organising research at the national level.

Barriers to co-operation and co-ordination

Not just the absence of programmes in some countries but also the variety in terms of focus and objectives of the existing programmes point to the difficulties with which any European initiative to achieve a better co-ordination and co-operation between programmes in support of SD is faced. This applies in particular to article 169 but also to any other bi- or multi-lateral initiative. It would need to accommodate these different national approaches and frameworks in order to develop joint actions in a way that is beneficial and legally feasible in each country. The motivation to overcome these difficulties is that there are synergy effects to be gained through better co-ordination, even if the analysis proves that the issue of how to design research in support of SD is still an open question.

New methods for addressing SD in research

One recent trend that can be observed is the move towards leaving more traditional approaches to organising research activities in support of SD and adopting new integrated and interdisciplinary approaches as some of the examples of programmes from Germany and the UK have shown. The more traditional approaches will not achieve the objectives of SD and new approaches that include a broader selection of stakeholder and explore new ways in terms of financing and funding practices are better placed to be able to address the goals of SD. However, these programmes are all still relatively new or in the development phase and the new approaches will have to be carefully monitored and experiences exchanged.

The need for radical research approaches

As reflected in the philosophies behind the new integrated and interdisciplinary approaches, research in support of SD is now regarded as a lever to explore the potential for radical shifts in technology and society. This implies that research work needs to have at least the potential to contribute to such a radical shift required to move towards sustainability. Consequently, research programmes need to facilitate the exploration of such more radical research paths, radical in technological terms as well as in terms of societal experimentation.

This points to a number of challenges that need to be addressed to enable the setting up of co-operation arrangements at European level that meet the requirements of research in support of SD.

First, research activities in this area will only succeed if they are supported by the existence of an institutional context that is able to design and implement such programmes. The current institutional settings are not yet fully geared towards facilitating the kind of inter- or trans-disciplinary research required. This may improve with the definition of new procedures and structures of the European Research Area and the Sixth Framework Programme.

Second, new programmes and approaches will not succeed if there is a lack of co-ordination on a national level with for example different ministries being responsible for the design and implementation of research programmes in isolation. In other words, co-operation at European level concerning the design and organisation of research programmes in support of SD requires addressing some of the barriers that exist on the national level.

Third, while integrative research programmes may be an important element to move forward SD, they nevertheless need to rely on in-depth disciplinary research findings. Integrative research programme should thus be seen as complementary to conventional research work.

A further challenge involves encouraging the development of a research community that is able to work within these new remits. The current number of researchers who are familiar with trans-disciplinary research is small. However, encouraging this trans-disciplinary research is not a simple task due to the lack of recognition received in the scientific community.

Evaluation for optimising Sustainable Development research

Experiences from the Austrian research programme "Cultural Landscape Management"

M. Krott

Georg-August-University Göttingen
Büsgenweg 3, D-37077 Göttingen
mkrott@gwdg.de

Challenges of Sustainability

Sustainability is a highly appreciated goal promising to everybody a little bit of a guarantee for security and survival within a dangerous world. Despite the strong general legitimisation sustainability becomes a tricky and very conflicting task as soon as policy tries to implement the goal. Measurements for sustainability get in conflict with the interests in growth, which are the driving forces of economy and society. The prices for sustainability are reduction of short time growth offending the poor and distribution of wealth offending the rich. No wonder that meeting the challenges of sustainability is extremely tough for policy.

As a consequence of the difficult task for policy the research programme for sustainable development, too, cannot expect quick success. It is much easier to achieve good results and receive applause of the society for research in new growing fields, e.g. the breathtaking options of biotechnology, than for the sober topic of sustainability. Therefore research in sustainability has an urgent need to focus all its power on the few chances for success and as a presupposition to that to find the best chances in the wide field of research activities. In both tasks evaluation can help.

Evaluation as a guide to the success factors

Evaluation means to investigate the progress of research programs and to compare it with the targets of sustainability (Krott 2002). Keeping the difficult situation of sustainability in mind it is easy to forecast that the results of the evaluation of the major research programs will be mostly deficits and faults. The scientific results and the impact in the field will be far behind the target of turning the growth trends around into sustainable development. The list of shortcomings will be so long and the working load to investigate them all so huge that the few success stories could easily be overlooked. The opposite strategy is rational and effective. An evaluation focusing on the success factors produces information with higher relevance for optimising research in sustainable development.

The evaluation will detect for the research managers and the scientists the specific research activities, which contribute to new applicable insights supporting sustainable development. In addition to the internal information an external effect is caused by the evaluation making the success visible for the society and the political system. Both informations are indispensable if research will contribute to gather all available forces behind the mission of sustainability.

The task of success-oriented evaluation can be worked out by different tools for evaluation. In order to discuss key elements of evaluation tools three basic types of evaluation can be differentiated: evaluation by the scientific community, meta-scientific evaluation and political evaluation. Their different abilities to find success factors will be discussed and illustrated by the inter- and trans-disciplinary research programme "Cultural Landscape Management" which the Austrian Federal Ministry of Education, Science and Culture has been running since 1992 comprising 500 scientists of 40 disciplines and targeting to trigger impacts on the sustainable development of the Austrian landscape (Bundesministerium für Wissenschaft und Verkehr, 1998).

Evaluation by the Scientific Community

Within the type of evaluation by the scientific community the procedure of peer reviewing is widely used. A group of competent scientists makes a judgement of the scientific merit of the project. For the success it is decisive to chose scientists who are the best experts in the field and who have no personal interests in the project. In order to deal with a project in sustainability, which will very often be trans-disciplinary, experts from the field who bring in practical knowledge can enlarge the group.

Focusing on the problem of sustainable development

Within a trans-disciplinary project about sustainable development the problem to be investigated and solved has two dimensions: a scientific and a practical one. The crucial point is how good both parts fit together. Scientists have the tendency to use the practical issue as an umbrella term under which they can focus their research on specific scientific questions, which are only loosely connected with the practical problem. In addition, the issue of sustainability is often misused to legitimise the research and the funding but does not guide the questions. The peers are able to detect the few projects, which indeed focus on the problem of sustainability.

Trans-disciplinarity by sufficient disciplinary standards

Trans-disciplinary projects are focused on maximising the contribution to solve problems. Therefore they cannot simultaneously maximise the scientific standards on how they are defined by the disciplines. Nevertheless, a sufficient minimum scientific standard is needed to produce knowledge at all. The peers representing specific disciplines know their standards very well and try to maximise the disciplinary standards in order to improve research from their point of view. By these standards they will kill innovative projects in sustainability, which are focused on the impact of problem solving and not so much on producing new disciplinary insights. During the first review rounds within the programme “Cultural Landscape Management” we experienced the danger to lose the projects which were most innovative in inter- and trans-disciplinarity, just because the peers were much more familiar with their own discipline. In order to meet the needs of trans-disciplinarity the evaluation has to formulate guidelines for the peers requiring sufficient minimal disciplinary standards and avoiding maximisation.

Repeated search for long term success

Applying knowledge for new solutions is not a simple transfer from the scientific project into practice. It is a long-term process of many years during which different target groups make use of the knowledge in different ways, which are still unknown at the beginning of the project. Simultaneously, the exchange with the practice is a two-way process with learning participants within science and practice. It is irrational not to accept the long-term effects and the two ways process just because these elements of appliance of scientific results do not match with the goals of a well-controlled project. Evaluation has to accept that the long-term effects are very important and cannot be predicted or checked within five-year periods. The evaluation must be aware of these limits and avoid overestimating the short-term effects just because they can be measured in time. Otherwise projects which produce short-term effects only are at an advantage.

A solution to this unintended misleading selection by evaluation is to recognise the limits and the inevitable high risk of research in sustainability. If this is true the evaluation cannot give an overall balanced final judgement on the quality of the project, but it can focus on finding the most innovative impacts. After some years the evaluation can be repeated and, maybe by looking at the strengths only, identify some additional important long-term effects. The success-oriented evaluation judges the success at the different stages of the project only and does not a final overall estimation.

Keeping such limits of the rational basis in mind, the final decision on the projects could be supported by random selection. About 25 % of the projects could be selected at random. By random procedures the probability to support very innovative projects is bigger than by an evaluation which is based on short-term and measurable effects only.

Meta-scientific evaluation

By a meta-scientific evaluation the project on sustainability becomes the subject of a scientific analysis producing facts about the performance. Despite the high complexity and camouflage from the perspective of the participants a research project is a social interaction which is not more than a medium challenge for a scientific meta-analysis. Most disciplines of social sciences and economics are well prepared by methodology to deal with even much more complex projects than research in sustainability. Therefore a very solid and efficient way to get facts on research in sustainability is to investigate it through different disciplines of social sciences, economics or philosophy.

Checking logic and economics

The strengths of science are the rule-guided and well-documented procedures. Most scientists share the basic principles of methodology. The rational of the hypothesis and the basics of the empirical methodology are the same for many different kinds of research. Therefore general specialists in methodology can contribute much in describing the formal part of the scientific procedures. Formally correct procedures do no mean successful research in all cases, but formally wrong procedures always mean failure of the whole project. E.g. if the project in sustainability makes use of a survey of target groups, such a survey must follow the methodological principles or it will produce misleading information. Therefore avoiding such failure is a basic requirement. But if it is fulfilled, a further requirement is to apply the formally correct methodology to the suitable questions and subjects. This is the domain of the experienced researchers themselves. Nevertheless they could get support by an evaluation of their formal methodology.

The argument is that the evaluation of the formal research procedures can identify avoidable, formal mistakes in the methodology, but it does not dominate the researchers in their key competence. This is comparable to an architect who is free in the design of a building but a neutral expert can only prove the structural engineering. Involving such neutral experts for methodology in trans-disciplinary projects is a simple and effective way of evaluating and improving the scientific quality.

An economic meta analysis can focus on the cost-benefit or cost-effectiveness of the interdisciplinary project. The cost-benefit analysis makes sense as far as the benefits can be quantified and transformed to a common measurement unit. To include additional effects cost-effectiveness can help. The effects have to be identified, but no monetarising is done. Comparing the costs in order to get the same effects is a test for the effectiveness of the project. Certainly economic analysis produces results within a tied reality only. Especially the accounting perspective has to be chosen. Efficiency for the participants, the sponsors or the society as a whole comprises different things. Nevertheless, a meta-analysis can substitute many interest-guided judgements on the project by sober numbers. Such an analysis is necessary to identify and support the most cost-effective projects.

Political selection in the field

Research in sustainable development intervenes in practice. The use of the knowledge has become part of many projects. Due to the fact that the interests of the stakeholders drive the use and not by any scientific principle, scientists generally have a very low understanding of the procedures which dominate the use of knowledge. Scientists tend to overestimate rationality and think that every man is a scientist or at least wants to develop in this direction. They have a hard time to understand that rationality is of minor importance in practice.

Even a simple meta-analysis by social sciences would enormously contribute to improve the strategies for the trans-disciplinary application. Additionally, the evaluation provides the scientists with information about the interests, problems and power of the field where the project is seeking for impact. E.g. many projects in sustainability are based on the idea that the stakeholders should produce a consensus about the problems and goals of the projects. As a consequence the projects very often come to an (unsuccessful) end already within the futile attempts to create consensus. The social science-based evaluation could show to the scientists that a basic ability to keep practice running is to act and to live together based on the agreement to disagree. The consequence for science is that the practice highly selectively makes use of the findings. Stakeholders do not feel comfortable with a comprehensive problem analysis. They even refuse such a view on the world and accept a tied reality only, which supports their interests. Farmers see for every ground the necessity to plant and breed whereas within the world of road builders the ground has to serve the basic need of roads and traffic. For getting an impact on sustainable development, projects must cope with such different views in detail, which can be shown by meta scientific evaluation.

Driving forces of research

Research projects are very much guided by strict rules. They require such specific roles for scientists and for users of scientific knowledge that the reality of research institutions, human beings, funding interests and user interests disappear behind the concept of the project. Evaluation based on social sciences or economics can provide qualified information about such additional factors within the project and the surrounding.

From the point of view of the scientist the driving force of projects has always been the desire to know more or to find the solution for sustainable development. Whereas the informal expectations of the stakeholders, the funding persons, research managers or the users differ substantially. Stakeholders want to minimise conflicts, maybe by buying time for avoiding decisions by sponsoring research; research managers want to support the growth of their institutions, staff and budgets. Users want authorisation for their own programs or new market opportunities for their products. E.g. a car producer gets exited about any concept for sustainability that makes use of cars with oil-effective engines but will never listen to scientific solutions which diminish the demand for mobility. Evaluation is able to show the formal and informal driving forces within the surrounding of the project. The informal factors are as important for identifying successful projects as the formal scientific concept.

Evaluation by Politics

Despite being neglected by most of the evaluation concepts evaluation by politics is by far the most important evaluation procedure. Politics means that the participants do not only follow the programs of science and the rules of the society, but they try to push their own interests by dealing with research. From the viewpoint of vested interests the scientific programs and the rules offer advantages and disadvantages. The key of politics is the power process to support advantages and to avoid disadvantages for the own interests. Evaluation is a useful tool for the participants to meet their interests.

Budgeting by modules

In politics the goal of sustainability is mainly a general formula in order to legitimise political activities. Consequently, the goal is too general to be used as a sufficient aim of a research program. A meaningful input by politics can be organised much better on a lower level than a whole program. The research programme can be split into modules, which combine targets with specified resources for the research done in this part. The setting of the formal priorities remains general, but informally the amount of resources determines the priority for the module. By building programs out of such modules, including resources, politics can give an important input into goal setting. E.g. it is not sufficient that a programme formulates highest priority for sustainability, because this goal will disappear among other highest research priorities. Providing specific goals with budgets does the effective priority setting. Therefore the amount of resources devoted to sustainability research has the most important effect in guiding research activities.

The instrument of modules offers a chance to enrich the budgeting process with the competence of the scientists. On principle, scientists should offer a variety of modules and the political stakeholders are supposed to choose some of them. The stakeholders' tendency to avoid conflicting priorities by reducing each project and distributing the funds to a wide range of projects can be altered by the principle to fund whole modules only and to forbid the reduction of the budget of specific modules. If the budget is exhausted, whole modules must be skipped. The modules force the stakeholders to set priorities within public research programs.

Markets for economic strong interests

The market is a powerful instrument to set politically relevant priorities. As far as stakeholders buy products of sustainability they give strong incentives for research in sustainability. The process of buying fulfils the criteria of evaluation. The buyers check the performance of research and compare it with their specific standards. Therefore it makes sense to think about the market of research results as an instrument of evaluation which matters in practice. Projects in sustainability with orientation towards the needs of powerful and economical strong groups and stakeholders are frequently bought on the markets. E.g. if the car industry combines different disciplines in developing prototypes of oil-effective cars, very successful research in sustainability is happening. The financially strong demand for specific products evaluates the research process and gives strong incentives for the best projects.

The main problem is that the market only works for products with a demand by groups who are financially strong enough to buy them. For many aspects of sustainability the demand is similarly strong, but no financial resources are available. E.g. projects aimed at developing a new sustainable traffic system are not as successful as the development of cars. This is not due to scientific difficulties, but due to the lack of resources available for powerful car industries.

Evaluation can help to overcome the lack of resources by looking for combined products for projects in sustainability. Part of the products should be marketable and earn some research funding; another part can be devoted to targets of sustainability without market abilities. Due to the complex goals of sustainability the chances should be quite good to design such a mixture of products. The programme of "Cultural Landscape Management" tries to identify such mixed projects in order to get financial support from the markets.

Lighthouse-communication strategy

The public and the media play an important role within the political evaluation. Every day the media report on problems of sustainability, which should be tackled by research and on the advanced technical, political and economic solutions. The strength of research becomes visible in the media, but the research deficits are shown in public, too. The high relevance of the media is well known. Nevertheless, special strategies are needed for the research in sustainability to make use of the dynamics of the media.

Basically, there are big differences between science and the media. The media focus on the most recent big results and inventions only. Whereas science gains new knowledge in a continuous process step by step without spectacular events. The sober practice of research is even for a well-meaning journalist much too boring. Further, scientists end up with dependent findings only offering proofs which are stochastically true. Such differentiation is far too complex for the media. Another difference is the language itself. The media communicate in an emotional language, which catches the attention of the users.

Despite these shortcomings in the content, the media communicate politically very important messages about research projects. Two messages are of highest relevance for politics: “trustworthy” and “competence”. The reports in the media focus on the two aspects whether the researchers are trustworthy in fulfilling the mission of science and whether the results contribute to the solution of the problems.

The language by which trustworthiness and competence is build up is not so much by communicating facts but mainly by symbolic messages. Sustainable research becomes visible in the media as long as it is connected with strong symbols of environment or society like global warming, greenhouse effect or ecological system. From the point of view of a scientist such words do not communicate the scientific content and are generalisations, which do not meet scientific standards. In the symbolic language of the media such words communicate important messages.

Accepting the dynamic of the media, the public and their objections to the concept of scientific discourses does not require to retreat from any public relations for projects. Instead of that the dynamics can be used for a lighthouse-communication strategy which is even able to meet the scientific standards. The reports within the media work as lighthouses showing within specific topics the most competent researchers with the best problem-solving abilities. Whoever gets interested has to get behind the lighthouse building up direct contact with the scientific project to find out more about the results. The lighthouses of sustainability are shining brightly by making use of the symbolic language and the biased analysis preferred by the media. They are built up in several different directions trying to be visible from different points of view. The goal is to attract and encourage everybody who could be interested in sustainable development – a quite big potential of people – to get in close contact with the programs, projects and researchers.

Summary

Policy and research for improving sustainable development are extremely difficult tasks, because whoever makes serious progress in sustainability gets in conflict with the strong interests in growth which are the basis of today’s life and politics. Due to these overwhelming political obstacles only a few research projects will be successful. It is recommended that evaluation focuses on the success stories and drives the research projects towards success factors. (1) Evaluation by the scientific community – like peer review – can bind the projects on the problems of sustainable development, but it has to extend the search for success stories far beyond the end of projects in order to find the long-term impacts, which are most important but cannot be identified in one final evaluation. Keeping the long-term uncertainty in mind, it makes sense to use random selection for certain parts (25%) of the projects. (2) Meta-scientific evaluation offers the economic and formal tools to improve the logic of the methodology and the efficiency of the management. Further sociological tools draw a realistic picture of the highly selective interests of the practice in implementing scientific solutions for sustainability. Finally the evaluation by politics can not be done by goal setting. A budgeting process, which combines research options with financial resources in specified modules, has much more impact. The market gives incentives for innovative research projects but works for economic strong interests only. Explaining the scientific content to the public and the media is a popular but nevertheless futile exercise. A lighthouse-communication strategy works much better. By speaking the symbolic and emotional language of the media the public attention is drawn to specific competent projects and researchers. Such information opens the door for everybody who is interested in building up direct contact with the projects and programs in sustainable development.

References

Bundesministerium für Wissenschaft und Verkehr (ed), Umweltwissenschaft im öffentlichen Auftrag, Wien 1998.

Krott, M., Evaluation of trans-disciplinary research, EOLSS Publishers Co. Ltd: Encyclopaedia of Life Support Systems, Oxford 2002 (in print).

Developing the practise of sustainable science, experiences beyond post-normal science

Silvio Funtowicz
Head, Knowledge Assessment Methodologies (KAM)

Institute for the Protection and Security of the Citizen (IPSC)
European Commission - Joint Research Centre (EC-JRC) TP 650
21020 Ispra (VA), Italy
silvio.funtowicz@jrc.it

Keywords: partnership, post-normal science, quality assurance, uncertainty.

This contribution by Silvio Funtowicz was published before as “Funtowicz, S., Ravetz, J. and O'Connor, M. (1998) "Challenges in the use of science for sustainable development", Int. J. Sustainable Development, Vol. 1, No. 1, pp. 99-107.”

Abstract

This paper summarises some of the challenges to science that are posed by the search for sustainability. These challenges are not only technical ones, such as more affordable or reliable equipment for health care, water quality control and refrigeration. There are also fundamental empirical and methodological challenges, such as complexity, irreversibility and uncertainty over the long term that must be faced for achieving better understanding of our environment and the planet's life-support systems. Finally, there are moral and procedural challenges for defining the roles of science-based knowledge and innovations for poverty reduction, for governance of technological and environmental risks, for sustainable ecosystems management, and for effective communication of scientific information to achieve these goals.

Barriers to the use of science for sustainable development

The strengthening of nations' scientific capability has been established as one of the cornerstones for the process of sustainable development. In paragraph 34 of the Report of the Secretary-General (UN Social and Economic Council (1998), addressing Science for Sustainable Development and referring to Chapter 35 of Agenda 2l, it is stated:

> *Each country must possess the scientific capability needed to master its own path to sustainable development. Given that the majority of developing countries today fall short of this objective, their national investment in higher education in science, and in scientific institution building, should be significantly increased. Specific attention should also be given to capacity building related to the development and implementation of national science and technology policies and systems of innovation. In this context, strong and concerted international support to build up the scientific community, and scientific infrastructures in developing countries, and in particular in least developed countries, is an urgent requirement.*

It is added, in paragraph 36, that `... research needs to become more pro-active and to focus on prevention and early identification of emerging problems - and also opportunities - rather than its present focus on tackling problems only once they become acute. This raises the questions of what sorts of problems are the most critical for sustainable development, and how science might best be mobilised in response.

Proposals for how best to use scientific knowledge to inform development policy actions mention a wide range of elements, such as: broadening the scientific base; integrating the physical, economic and social sciences; co-ordinating environmental data; building scientific capability.

In Chapter 35 of Agenda 21, which established as a priority the challenge of "strengthening the scientific basis for sustainable management", it was noted that "often there is a communications gap amongst scientists, policy-makers and the public at large...". Better processes for science communication are thus a fundamental component in the harnessing of science for sustainability. What is urgently required is to develop a process or processes that will ensure the involvement of all-appropriate scientific inputs and expertise. Scientific excellence and integrity needs to he combined with a close dialogue and co-operation with policy-makers and implementers, including full participation by experts with local knowledge in developing countries. Goals for improved science communication are then seen to include:

- Better lines of communication between scientists, policy-makers and the public concerning the gravity of the environmental and economic problems;
- Building up of endogenous capacity in countries currently having less developed science resources, improving their natural resource and ecosystem management capabilities and making possible a more effective harnessing of advances in science and technology;
- Deepening of co-operation between focal and external experts to ensure full understanding of the socio-economic, cultural and ecological circumstances as a precondition for successful science-technology implementations;
- Development of processes for assessing scientific uncertainty, for accommodating scientific dispute and for integrating stakeholder interests and perspectives in relation to technology and environmental risks.

The challenges posed by sustainable development to public policy

Advances in science are opening up new domains of potential technological innovation. with potentially vast consequences for interventions in human health, energy supply, food production and environmental engineering. These fields of advancing knowledge carry many hopes for humanity. Yet they also bring new risks to society and new challenges for quality assurance. These new tasks are the concern both of professional policy-makers and of the scientific community, and of the wider political community (Funtowicz and Ravetz, 1990, 1991, 1993; De Marchi, 1997).

Many of the past successes of science have been measured by the delivery of a new or higher quality product or service. These successes are demonstrated by spectacular engineering achievements, such as bridge and high-rise building constructions, and by less spectacular but equally important achievements such as reliable motor vehicle engineering or low cost and low-pain dental interventions. Many of the hopes for the contributions of science to development of long-run sustainable production and consumption patterns rely on the continuation of this impressive tradition of problem solving success. For example, the integrated management of fresh water, ensuring efficiency of use and technological mastery of purification and re-use systems, is a high priority in European development and environmental policy, and is a key component for many programmes aimed at food security, health and industrial development in developing countries.

In a word, our science and technology advances have greatly increased our capacity to exploit and transform our physical surroundings, and promise to extend continually this capacity. Yet the pursuit of sustainable development through science and technology is not without risks, and some of these risks are inherent in the potentialities of science and technology themselves.

- The permanent process of pushing back the frontiers of knowledge and science-based interventions also confronts us, in new ways, with the limits to our knowledge and intervention capacity (Ravetz, 1996; Waltner-Toews and Wall, 1997).
- Our knowledge advances permit more and more sophisticated interventions in ecosystem functioning and in the components of life itself; yet our scientific understanding of the physical environment and of the impacts of human activity on life process and ecosystems remains very incomplete and, in many cases, lags behind our interventions (O'Connor, 1994x, 1994b, 1994c).
- Science-based innovation has, in the past, contributed to industrialisation processes that have proven highly disruptive to ecosystems at local and global levels. Some of the new commercially attractive technologies may also be incompatible with ecological stability and environmental quality goals.
- On a socio-economic plane, there are fears that commercially driven innovation and technology transfer can work to heighten socio-economic stratification, and so worsen poverty for disadvantaged populations rather than reduce it.

The promotion of science for sustainable development thus requires procedures for evaluating science and technology contributions against criteria for sustainability. Developing the necessary awareness for such evaluation is a major challenge. Building up an evaluation capability - in the developed as well as the developing countries - is a process that must involve policy-makers and the public at large as well as the scientific community itself.

A long-term perspective must be adopted that confronts the deep ambiguities of technological innovation. One feature of many new domains of science-based innovation is their intervention in complex biological and ecosystem processes where quality assurance in terms of outcomes is almost impossible to conduct. This difficulty warrants some reflection. It has long been recognised that industrial production activities, mass consumption and intensive agriculture can have unwanted negative effects on ecosystems and environmental quality. What has more recently been emphasised is that some of the adverse consequences can be very long-term and also very difficult to control.
Examples of effects that can be felt over very long time-spans include land degradation, salinization of aquifers, pesticide residues and emissions of durable toxic wastes that may accumulate in ecosystems and in food chains, radioactive wastes from nuclear reactors, and climate changes provoked by increased releases of carbon dioxide (and other greenhouse gases) into the Earth's atmosphere.

- Examples of interventions in social, economic and ecosystem processes that, once initiated, cannot easily be mastered include: changes or increased variability in hydrological and regional climate patterns due to the enhanced greenhouse effect; the "environmental release" of "transgenic" organisms for food production or other purposes; the cloning of animals (including perhaps humans); the presence of BSE (mad cow disease) in cow and, perhaps, human populations (Grove-White et (it., 1997; Funtowicz and Ravetz, 1994x, 1994b; Matthews, 1998).

As these and other examples suggest, we must now integrate the awareness that science based interventions in complex natural processes can constitute, in themselves, a self-renewing source of problems that may jeopardise community livelihoods, health and future economic prospects. This is highly publicised for the risk in the electro-nuclear industry and in biotechnology applications based on genetic engineering. It is also true for the complicated yet fragile systems of food production and communication upon which modern societies depend. For example:

- Many of the "miracles" of increased productivity within the agro-food industry depend on a permanent utilisation of pest-control chemicals, fertilisers, hybrid or genetically modified stock, and other capital inputs. These technological developments can heighten the vulnerability of food production systems in the face of technological, economic or natural disruptions. The intensive production is also, in many regions, having serious negative consequences for soil and water quality, which will undermine productivity in the long-tern.
- In the fishing industry, mechanisation allied with sophisticated scanning technologies can dramatically increase catch effectiveness, yet the catch volumes (including discarded by-catch) in many of the world"s seas are putting at risk the sustainability of fisheries as a food resource for both rich and poor population.

A lesson that may be drawn from these (and other) examples is that the relationship between advances in science and in science-based technologies on the one hand, and sustainable development on the other hand, is multi-faceted and ambiguous. Just as the recognition of ecological constraints on the scale and forms of sustainable economic production and consumption means that "more output" is not the same as "good output", so it has to he noted that more scientific knowledge put to work in innovations does not necessarily lead to a more sustainable economic process.

Realising the potential of science for sustainable development

The principle of sustainable development has been conceived in response to perceived inadequacies of earlier models of economic development. Traditional growth-oriented economic development has not always improved the economic prospects of the poorer sections of the populations, in developing and developed countries alike. As well, the industrialisation process depends on natural resource exploitation, including fossil fuel and water resources, at rates and in ways that cannot be sustained indefinitely and that cannot be automatically transferred from the current developed countries to the developing ones. The agro-food industries are themselves contributing, in many cases, to the degradation of soil and water resources. New technologies, such as nuclear energy and genetic engineering, that show potential for relieving some environmental constraints, may also entail deepening environmental, health and technological risks.

Neither the advance of science in itself nor the widening of competitive markets can be expected to promote, as if "naturally", a path of sustainable development. On the contrary, the short-term orientations of much market-centred economic activity, and the mixtures of commercial, military and other strategic preoccupations that motivate much science-based technology development, can be antagonistic to the goals of ecosystem resilience, resource stewardship and social justice that may be considered foundations for long-term sustainability.

To promote sustainable development there needs to be explicit identification of the kind of future socio-economic order that we wish to strive for, together with policies that encourage research, knowledge exchange and science applications - a permanent social learning - in pursuit of these goals.

One of the implications is that the priorities for science content must evolve if science is to contribute effectively as a force for sustainable development. This is a message that has to he communicated not only to policy-makers but also to the scientific community itself. Jane Lubchenco in her 15 February 1997 Presidential Address to the AAAS (published as Lubchenco, 1998), synthesised the following indicator statement about environmental change:

> *Between one-third and one-half of the land surface has been transformed by human action; the carbon dioxide concentration of the atmosphere has increased by nearly 30% since the beginning of the industrial revolution; more atmospheric nitrogen is fixed by humanity than by all natural terrestrial sources combined; more than half of all accessible surface fresh water is put to use by humanity; about one quarter of the bird species on Earth have been driven to extinction; and approximately two thirds of major marine fisheries are fully exploited, overexploited or depleted.*

The exact calibrations and significance of the processes catalogued can be debated; what is important to note is that the rate and spatial scale of these changes is increasing. As Lubchenco suggests:

> *The current and growing extent of human dominance of the planet will require new kinds of knowledge and applications from science - knowledge to reduce the rate at which we alter the Earth's systems, knowledge to understand Earth's ecosystems and how they interact with numerous components of human-caused global change, and knowledge to manage the planet.*

Lubchenco has in this context called upon the scientific community to "formulate a new social contract for science" with the view that scientists should:

> *... address the most urgent needs of society, in proportion to their importance; communicate their knowledge and understanding widely in order to inform decisions of individuals and institutions; and exercise good judgement, wisdom and humility*.

This proposal shows a clear understanding that scientific practice is not fundamentally "value-free" but that it has to find its justifications by reference to prevailing social concerns. Similar views are now voiced widely in scientific networks (e.g. INES, 1995) and in development fora (e.g., Kammen and Dove, 1997, on "the virtues of mundane science" oriented towards solutions for everyday problems of the poor in developing countries). The objective of scientific endeavour in this new context may well he to enhance the process of the social resolution of the problem, including participation and mutual learning among stakeholders, rather than a definitive "solution" or technological implementation. This is an important change in the relation between the problem identification and the prospects of science-based solutions. Stated schematically:

- Science is no longer mainly offering the "benefit" of new discoveries and applications, as a sort of added-value from investment.
- Rather it is placed in the reactive role of trying to fill a "knowledge deficit" as awareness grows of problems such as hazardous wastes, water contamination, renewable resource depiction, climate change, other atmospheric pollution and disruption to aquatic and terrestrial habitats.
- Analyses are, increasingly, being sought that can contribute to technological and policy responses. In this respect we can speak of a scientific activity that is designed around serving the goals of sustainable development.
- However, this "science for sustainability" will be issue-driven, as well as curiosity generated or mission-oriented. It will address problems that arc salient for sustainability, regardless of their capability for a traditional "solution". These will include complex and difficult issues, even those where our knowledge is swamped by uncertainty, ignorance and value-conflict.

The agenda of sustainable development thus means, in this regard, the guidance of scientific work and technology applications towards innovations that respect fundamental sustainability values such as local ecosystem resiliency, mitigation of global climate change impacts, energy efficiency, food security, and enhanced problem-solving capacities of local populations. An important part of this guidance and justification, we suggest, is the design and implementation of agreed social processes for quality assurance in science knowledge and technological implementations. This will entail the emergence of new social institutions to perform the quality assurance function. In this style of science, place-specific knowledge and resource of local communities will need to he integrated as complementary to the universal knowledge of traditional scientific practice (e.g., Pauly, 1995, on fisheries ecosystem knowledge).

The complexities of modern science-based production and environmental engineering practices pose radical new challenges for public policy. These not only relate to priorities directly in research funding and science policy, they also extend to vast areas such as public health, agriculture, energy policy and infrastructure investments. For example:

- The international agreements of Kyoto (in December 1997) for moves towards worldwide stabilisation and eventual reductions of greenhouse gas emissions have been widely heralded as a step towards implementation of sustainability principles. At the same time, they sharpen some other development-environment tensions including (a) risks associated with use of nuclear power, and (b) historically rooted North-South asymmetries in the distribution of benefits from industrialisation processes.
- The question of options and dilemmas concerning what to do with spent nuclear reactor fuel and the radioactive wastes associated with reactor decommissioning, is now the object of very detailed scientific and societal enquiry in several European nations. For example, the debate about the "reversibility" of radioactive waste storage options reveals the underlying anxiety about the difficulty of guaranteeing - at the level of societal assurance of stewardship as well as technological mastery of containment - a "safe" disposal process for wastes whose nuisance lifetime is in the order of hundreds or thousands of years.

- The new challenges of biotechnology risks include those that are not quantifiable yet are potentially serious with irreversible health or ecosystem consequences (such as, genetically modified crop plants). Also, there is considerable scepticism amongst populations of many developing countries concerning the distribution of any benefits eventually arising from commercially appropriated genetic innovations.
- The "mad cow" misadventure has highlighted, in the public mind, the absence of a reliable quality assurance process for the governance of science and technology in. the field of food production. In some countries this has acted to reinforce public distrust of "experts" and of the solutions that technology and science might be able to propose to health risks and environmental problems.

Those who place their faith in science and technology may suggest that knowledge advances can, in themselves, in due time bring solutions to the dangers, disruptions and dilemmas that earlier science and technological interventions have generated. We propose, however, that the inherent complexity, high stakes and urgency of sustainable development is not something that can be handled by technological advances alone. New quality assurance processes are needed for science and policy for sustainability, based on wide societal and ethical reflections.

Closing the communication gap

The strengthening of nations' scientific capability is an important component of the achievement of sustainable development. This capability should be understood in relation to the new challenges posed by sustainable development to science. Attention must be paid to the cases where the applications of science to technology and agriculture might have unexpected and unwanted side effects. The relationship between science (and the science-based technologies) and development is multi-faceted and ambiguous.

If sustainability goals are to be achieved, science and technological development as potential forces for public good have to be guided by a quality control process based on explicit ethical, political and epistemological reflection. New notions of social responsibility in public policy and science will need to be explored.

The old conception of scientific communication as a one-way traffic of information from the experts to the public has to be replaced by a notion of partnership through reciprocal learning among those involved in the process. The deep involvement of policymakers and the public in the quality assurance of innovations in science and technology thus becomes necessary. Scientists must learn as well as teach, policy-makers must specify their needs and accept uncertainty as well. And the general public must use their discrimination on scientific questions as on all others of public concern. It is in such tasks that the communication gap between scientists, policy-makers and the general public can be overcome, With such considerations in mind, capacity building for science in the developing countries can be accomplished to the best effect. The major challenge for science for sustainable development is, indeed, bridging the communication gap in such a way that a process of mutual learning and trust can be established among all the parties.

Acknowledgements

The first version of this paper was prepared for the Panel Discussion on "Science and Sustainable Development" organised by the British Presidency of the European Union, at the 6th Session of the United Nations Commission on Sustainable Development, New York, 22 April 1998. The paper was subsequently also presented at the Tenth International Conference of the International Society for the Advancement of Socio-Economics (SASE 98) on the theme of "Challenges to the future: structural changes and transformations in contemporary societies", Vienna International Centre, 13-16 July 1998. The opinions expressed are those of the authors and do not necessarily constitute UN or EU policy. Thanks to Alan Apling, Nadine Gouzée, Denis van Eekhout, Till Vegas, Cornelia Naked, Peter Wills, Gilbert Glassier, the members of the CDs Panel, and many others for their inputs and assistance.

References

De Marchi, B. (1997) "Seveso: from pollution to regulation", Int. J. Environment and Pollution, Vol. 7, No. 4, pp.526-537.

Funtowicz, S.O. and Ravetz, J.R. (1990), Uncertainty and Quality in Science for Policy. Kluwer Academic Press, Dordrecht.

Funtowicz, S.O. and Ravetz, J.R. (1991) "A new scientific methodology for global environmental issues", in Costanza, R. (Editor). Ecological Economics. Columbia University Press. New York, pp.137-152.

Funtowicz, S.O. and Ravetz, J.R. (1993) "Science for the post-normal age", Futures, Vol.25, No.7, pp.735-755.

Funtowicz, S.O. and Ravetz, J.R. (1994a) "The worth of a songbird: ecological economics as a post-normal science", Ecological Economics, Vol.10, pp.197-207.

Funtowicz, S.O. and Ravetz, J.R. (1994b) "Uncertainty and regulation", in Campagnari, F. (Editor) Scientifc-Technical Backgrounds for Biotechnology Regulations, ECSC/EEC/EAEC, Brussels and Luxembourg, pp.133-142.

Grove-White, R. Macnaghten, P., Mayer, S. and Wynne, B. (1997) Uncertain VVorld: Genetically Modified Organisms, Food and Public Attitudes in Britain, research report by the Centre for the Study of Environmental Change (CSEC), Lancaster University, Lancaster, March 1997.

INES (1995) Annual Report 1995 of the International Network of Engineers arid Scientists for Global Responsibility, INES Office, Dortmund, Germany.

Libchenco. J. (1998) "Entering the century of the environment: a new social contract for science", Presidential Address to the American Association for the Advancement of Science, IS February 1997. published in Science Vol.279, 23 January 1998, pp.491-497.

Kammen. D.M. and Dove, M.R. (1997) "The virtues of mundane science", Environment, Vol.39, No. 6. pp. 10 -15.

Matthews. R. (1998) "Hidden perils", New Scientist, 21 February 1998, pp.16-17.

O'Connor. M. (1994a "Complexity and coevolution: methodology for a positive treatment of indeterminacy", Furores, Vol.36. No.6, pp.610-615.

O Connor. M. (1994b) "Thermodynamique, complexité et codépendance écologique: la science de la joie et du deuil", Revue Internatíonale de Systématique, Vol.8. Nos.4/S, pp.397--423.

O Connor, M. (1994c) "Entropy, liberty and catastrophe: on the physics and metaphysics of waste disposal". Economic Analysis, Kluwer, Dordrecht/Boston/London; pp. 119-181.

Pauly, D. (1995) "Anecdotes and the shifting baseline syndrome of fisheries", TREE, Vol.10, No. 10. October 1995, p.430.

Ravetz, J.R. (1996) "The microcybernetic revolution and the dialectics of ignorance", in Ravetz, J. and Sardar. Z, (Editors), Cyberfutures, Pluto Press, London, pp.42-60.

UNSEC (1998) Report of the Secretary-General prepared by the UN Social and Economic Council on Capacity Building, Education and Public Awareness, Science and Transfer of Environmentally Sound Technology (Chapters 34, 35, 36 and 37 of Agenda 2 1), for the 6th Session of the Commission on Sustainable Development, United Nations, New York.

Walter-Toews. D. and Wall, E. (1997) "Emergent perplexity: in search of post-normal questions for community and agroecosystem health", Soc. Sci. Med. Vol.45, No. 11 pp.1741-1749.

European and global approaches IDD overview, classification and characteristics of scientific tools for a Sustainable Development policy

T. Bréchet, P.-M. Boulanger

P-M. Boulanger
Institut pour un Développement Durable
Rue des Fusillés, 7 B-1340 Ottignies Belgium
E-mail : idd@euronet.be

Th. Bréchet
Lhoist Berghmans Professor of Environmental Economics and Management
CORE - Université catholique de Louvain
Voie du Roman Pays, 34 B-1348 Louvain-la-Neuve Belgium
E-mail : brechet@core.ucl.ac.be

Introduction

Formidable challenges confront policy-makers who have publicly stated their commitment to sustainable development. However, because sustainable development is such an all-embracing concept, there is a natural tendency for governments to include all desirable policy goals. The fact that sustainable development encompasses many controversial issues and competing objectives makes it a normative concept by nature. Whether a sustainable science is desirable or possible from an epistemological perspective is less our concern than the necessity to embrace all this complexity for a more comprehensive decision-making process.

Acknowledging the complex linkages involved by sustainable development policies represents an important step towards constructing future policies. This complexity ought to be captured inside the tools used for decision-making, even if no single discipline can cope with the multiplicity of issues involved in sustainable development.

As yet, there is no specific approach or framework that attempts to define, analyse and implement sustainable development. No single discipline could cope with the multiplicity of issues involved. It may be discussed whether sustainable development could really become a brand new discipline by itself, but is it really necessary? Sustainable development is not a discipline: as stated by Godard (1993), it is a programmatic and dynamic concept (procedural approach). It is widely admitted that the current path of development is unsustainable but the definition of what is sustainable is still in discussion. Discussion of the meaning of sustainable development is clearly important if we want to understand what policy-makers are striving to achieve. From this point of view, substantial progress has been made in clarifying the many controversial issues that have emerged from the Brundtland Report definition.

Yet, the question addressed today is the following: how tools and models could be improved to help decision-making in the field of sustainable development? It is obvious that, up to now, sustainable development has mainly been considered from the perspective of existing applied models or tools. These models or tools were originally conceived for handling traditional economic policies and, even if they have been sometimes adapted in order to integrate more environmental dimensions, they do not necessarily encompass the very characteristics of sustainable development. The aim of this paper is to identify these characteristics and to confront them to the existing tools and models used, today, in support of decision-making.

The paper is organised as follows.

A first section describes the decision-making process and the need for relevant tools. This analysis will show how each kind of tools is expected to bring a specific contribution within this process. The following section will present our methodological framework: it is based on a set of five criteria used to characterise sustainable development issues. From this, the difference between tools and models will be explained in another section. The set of criteria designed for SD issue analysis is presented in section 4. These criteria are the following: interdisciplinarity, uncertainty, long-term perspective, global and local dimensions and stakeholder participation. Section 5 confronts the main tools used for decision-making to these criteria. Conclusions are drawn in the last section.

The decision-making process

As a starting point for our discussion of the various tools available for a "sustainable development oriented" decision-making, let us start with the general representation of a decision problem in the so-called "decision theory" (French, 1984).

Formally, any decision problem may be represented by a decision table where each row is assigned to one element (I) of the set of possible actions to be considered by the decision maker, and each column to a possible state of nature (j) i.e. the outcome of all the external factors which are beyond the control of the decision-maker ( ).

At the crossing of row i and column j, one finds the consequences of action i provided one observes the state of nature j, say xij.

Table 1. Decision table: the general form

States of nature					
Actions		θ_1	θ_2	…	θ_n
	α	χ_{11}	χ_{12}	…	χ_{1n}
	α	χ_{21}	χ_{22}	…	χ_{2n}
	.	.		…	.
	.	.		…	.
	.	.		…	.
	α_m	χ_{m1}	χ_{m2}	…	χ_{mn}

It is apparent from Table 1 that:

- the set of all possible actions has to be known and finite;
- they are mutually exclusive and only one is to be chosen;
- the set of all possible (mutually exclusive) states of the world has to be known;
- the consequences of each action for every possible state of nature have to be known.

Once all these conditions are satisfied, the decision-making problem boils down to:

- evaluating the alternatives which amounts to replace the different consequences in Table 1 with their value ("utility") for the decision-maker;
- selecting the best alternative, which is just choosing the action leading to the highest valued consequence.

So, decision-making is best understood as a whole process consisting of identifying feasible actions, valuing and evaluating their likely consequences then selecting the most appropriate sequence of actions and monitoring their impact, this process being eventually started again in case of a discrepancy between the expected and the observed consequences. This process is displayed in figure 1.

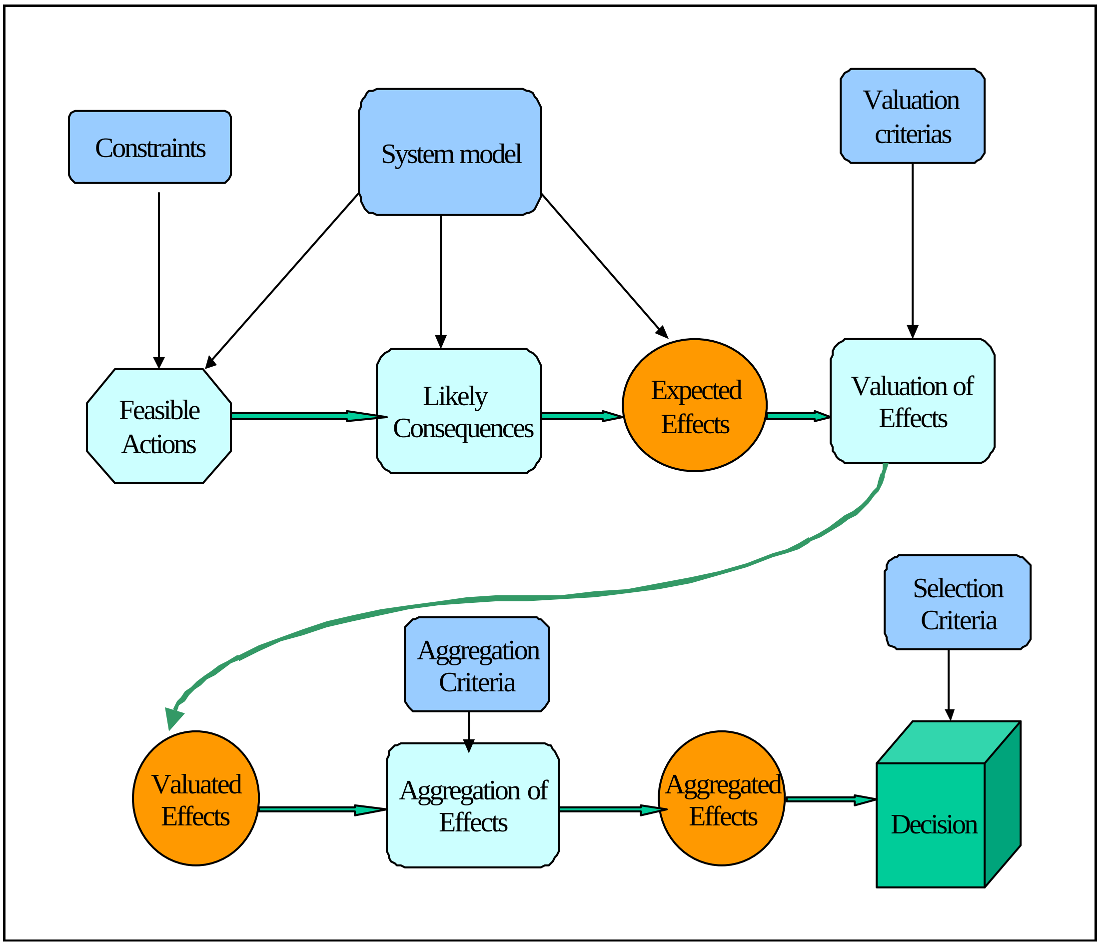
Such a representation helps us to identify what type of tool is needed at the different stages of the decision sequence. One may classify these tools in two broad categories: actor- oriented and system oriented tools. Indeed, it is clear that decision-making involves at least two interacting systems:

- the decision-maker 's own objectives, goals, values and constraints, and
- the target system one wants to control, upon which one wants to act.

What tools for decision-making?

The operations of valuing, aggregating and choosing as dealt with by decision theory are all on the decision-maker side. Conversely, the upstream operations consisting in identifying feasible actions and anticipating foreseeable consequences are mainly on the target system's side. It follows that rational decision-making involves two different toolkits: one focusing mainly on the decision-maker's side of the problem (what preferences? what values?) and another one to analyse what can be done with and on the target system, how it is likely to react to such and such decision, etc.

Figure 1: The decision-making process (adapted from Walliser, 1977)



The first category is then made of tools designed to help the decision-maker in clarifying one's own constraints, goals, objectives and preferences and in translating them in a language that allows their rational analysis. They deal also with the valuation and ranking of expected consequences and the selection of the optimal action.

Usually, the evaluation of alternatives is based on balancing costs and benefits (monetised as far as possible), and aggregated over different dimensions: time (which leads to the discounting problem), stakeholders (which leads to the aggregation problem), domains (weighting problem).

Table 2 shows how the most widespread methods handle the valuation and selection problem.

Sustainable development with its emphasis on long-term and global effects, its concern with the environment and biodiversity and its insistence on democratic participation in decision-making is particularly challenging for these methods, specially with regard to evaluating non-marketable effects and aggregating interests of spatially or temporally very distant populations. But we will not dispute that, despite their well-known shortcomings, they have something to offer, even in such a challenging context (Ekins, 2000).

The toolkit enabling the decision-maker to identify the set of feasible actions and anticipate their consequences is mainly composed of databases and models

Table 2: Main decision-making methods (Walliser, 1977)

Name	Valuing	Selection criteria
Cost-Benefit Analysis	All consequences are monetised	Maximisation of net aggregated monetised consequences
Cost-Effectiveness Analysis	One effect quantified (target) All others monetised (costs)	*Maximisation of effectiveness at a given cost* - Minimisation of cost at a given effectiveness - Maximisation of the effectiveness/cost ratio
Multi-Criteria Analysis	N quantified effects	Various methods

Models

Generally, a decision consists in selecting an action (or a full sequence of actions) to be performed by one or several actors in order to induce some change in a target system and lead it to a state deemed more beneficial for the decision-maker. This would be impossible without at least an informal mental representation of the system and a - however diffuse - distinction between the elements of the system on which it is possible or most useful to act and other elements deemed to be less controllable or even uncontrollable.

One calls models the representation of the system and control variables the elements of the system that the decision-maker can control.

Control variables are at the intersection of the target's model and the actor's one. Indeed, they belong to the target system model as the ones on which it is possible to act in order to modify its spontaneous trajectory but at the same time they belong also to the actor's or decision-maker's model insofar as they are under her control. The distinction between control variables and other variables (state variables, input and output variables) is what makes models used in decision-making (sometimes called applied models) different from scientific or theoretic models which have no use of such a distinction insofar as they don't aim at transforming reality but just explain, predict or analyse it.

Databases

Alongside models of the system to be geared, what we find in the policy decision-maker's toolkit is one or several databases containing records about the target system and on the decision-maker resources. The database is structured in the same way as the decision table. Actually, in the most usual model of database system (the relational model of data), it is designed as a table where columns refer to the attributes of the system and rows to the various entities composing it – in a cross-sectional approach - or to the same system across time in a chronological one (Date, 1986). At the crossing of row i and column j one find the value of attribute i for entity j or at time j. For instance, rows may refer to successive dates, or geographical entities such as cities or regions and columns to variables such as GDP, population, CO_2 emissions, etc.

In the context of decision-making, we can think of the columns of the tables composing the database as indicators, the values of which for several years or various entities form the records of the database.

What distinguishes an indicator from a variable? Not much: indicators are just variables which carry information on directly unobservable characteristics of systems which are of some relevance for an actor (Bunge, 1981). We speak of them as indicators because we don't observe them for their own sake but in reference to a problem or an objective on which it shed some light.

Designing sustainable development criteria

The intrinsic complexity of sustainable development issues is regularly pointed out. Basically, this means, as stated for example by van den Bergh and Hofkes (1998), that one has to address the complexity of relationships between actors and components of the economy-environment-institution system over time. A limited number of criteria is systematically used to characterise these relationships. These criteria and their intricacy are stated to demonstrate why sustainable development should not be considered like any traditional matter of concern. Some researchers are even seeking for a new discipline, called for example "sustainomics" by Munasinghe (2001) or "sustainability science" by Kates et al. (2001). Without discussing here this research for a new paradigm, we can see that sustainable development is typically characterised by the five followings criteria: an interdisciplinary approach, taking uncertainties into account, in a long-term perspective, both from global and local dimensions with an implication of the stakeholders.

Inter-disciplinarity

Sustainable development is originally considered as the necessity to find an equilibrium between the economical, social and environmental dimensions (the "three pillars") of development. From a science perspective, however, interdisciplinarity means that any comprehensive analysis of a sustainable development issue requires insights from several scientific disciplines such as natural and social disciplines (physics, biology, sociology, economics, politics, demography, etc…).

The level of integration between the different disciplines (the degree of interdisciplinarity) depends on the subject of matter. More interdisciplinarity is certainly also needed if one consider sustainable development as a process where every form of productive capital must stay in line with each other. By this we mean manufactured capital, of course, and natural one but also human and social capital as well. These specific assets together form the productive base of any society, which must remain non-declining from generation to generation for development to be characterised as sustainable (Dasgupta and Mäler, 2000). Speaking of non-declining overall productive capacity would lead to the fundamental and difficult issue of existence and limits of substitutions between various type of capital good. Clearly, it cannot be considered without a better understanding of the dynamic interactions and feedbacks between natural and socio-economical systems.

Uncertainty

The fact that decision-making is undergone under many uncertainties is far from being something new (Funtowicz and Ravetz, 1990). The sources of uncertainty are numerous, coming from an imperfect knowledge of the initial system and of the impacts of the policies considered (Handmer et al., 2001). Threshold effects and irreversibility can also reinforce the consequences of a policy and entail excessive social and economic costs if they are not correctly anticipated. In decision theory, risk is defined by the fact that the distribution of probability of outcomes is known; if it is not the case, we talk about uncertainty.

Long-term perspective

Sustainable development is expected to be a development that lasts. At first sight, this can be understood as the need for a long-term perspective, for example concerning the management of exhaustible resources or population trends. This perspective also introduces the fact that several phenomena evolve over very different time-scales and are not synchronised (climate system, population, technical progress, internet technologies…). Yet, long-term is more than a strictly temporal question and addresses the question of intergenerational equity (see the definition of sustainable development from the Brundtland Report).

Global and local dimensions

Climate change is one of the best examples of a global problem: climate change mitigation policies require a worldwide solution and agreement and every country would benefit from it. However, the global dimension does not necessarily means “world-wide”: it means that, for a given stakeholder, the costs and benefits of a policy are not directly linked and dependent on their own actions (this is based on the externality concept). Furthermore, one can see that over the long-term, the global dimension is becoming more and more important (externalities are playing both from the static and dynamic point of view). Sustainable development requires not only tackling the global dimension but also the local dimensions. More precisely, this means that impacts and actions are to be evaluated at any level, starting from the anonymous people (as a citizen, consumer, worker, politician…) up to governments or any organised social, political or economic institution.

Stakeholder participation

The participation of stakeholders is an important feature for sustainable development. It is linked to good governance and democracy, but it is all the more crucial as the questions addressed are global or uncertain. The role of stakeholders has to be recognised and their viewpoints taken in consideration.

Relationships between criteria

These five criteria should not be considered separately. The following matrix (Table 3) displays the links between the criteria based on the following relationship: “criterion i requires tackling criterion j”. This relationship enlightens the interactions between the criteria and shows which one is driving the other.

A cross in the cell (i,j) indicates that there exists a relationship between the criterion in row i and the one in column j.

As an example for the elaboration of the matrix, we can consider the line for the criterion “long-term”. As soon as we adopt the long-term perspective criterion, it “makes necessary” to also take into account interdisciplinarity because long-term introduces synchronism between evolutions from different fields such as demography, ecology (natural systems resilience), resources management, etc… Long-term criterion also “makes necessary” to tackle uncertainty since it becomes all the more important as the time-span is increasing. Finally, the long-term criterion implies to take into account the global dimension of the question considered, as stated above. On the other hand, applying the long-term criterion does not strictly “make necessary” to include the role of stakeholders, except for the future generations, but they already represent the core of the long-term criterion.

All the rows of the matrix are elaborated from such discussions. Of course, some of the relations stated here may be further discussed.

Table 3. Relationships between the criteria

"Makes necessary"	Interdisciplinarity	Long-term	Uncertainty	Global Local	Stakeholders
Interdisciplinarity		X			
Long-term	X		X	X	
Uncertainty	X				X
Global - Local	X				
Stakeholders	X			X	

What is particularly interesting is the analysis of the matrix. The crosses below the diagonal indicate the "driving criteria" (those which make the others necessary). The crosses above the diagonal indicate the "driven criteria" (those which are made necessary by the use of another criteria).

This analysis can first be done by columns; it shows that:

- Interdisciplinarity represents the very core dimension of sustainable development issues since it is "made necessary" by all the criteria. Whatever the criterion considered, it requires an interdisciplinary approach.
- All the criteria without exception are "made necessary" by at least one criterion (there is always a cross above the diagonal).

The analysis by rows shows that:

- The long-term criterion is the most influential one (there are three crosses in its row).
- All the other criteria exert at least one influence on another criterion.

A confrontation between tools and criteria

In a perfect world, efficient tools for decision-making in sustainable development should take into account simultaneously the five characteristics depicted above for any political issue considered. Most of the traditional tools used today fall short of this. The present section will review these tools starting from the five characteristics and searching for the scientific approaches, which are amenable to renew the practice of modelling.

This review of tools and models will focus on two fields for which sustainable development issues are particularly relevant and literature abundant. These fields are simply taken as examples. The first one concerns energy issues: among the issues considered, one can think of climate change mitigation, management of exhaustible resources, pollution, health, transport... The second one is related to land use and urban planning: it addresses questions such as infrastructures, mobility, alternative land uses, urban pollution…

Interdisciplinarity

This can be seen as a paradox but interdisciplinarity is maybe the criterion for which a large number of tools and models are pretending to fulfil. As far as energy issues are considered, integrated assessment models (IAMs) or even E3 models (Energy, Environment, Economy) pretend to be interdisciplinary. This arises from the fact that it is difficult to identify whether a tool is interdisciplinary or not, or to what extend it is interdisciplinary. For the researchers and practitioners, a tool or model often becomes interdisciplinary as soon as a productive collaboration is undergone with other scientific fields: this should better be considered as multidisciplinarity.

A real interdisciplinarity methodology requires at least two methodological features:

- the first one is the existence of a formal feedback between the different fields considered in the system (for example, a feedback between the environment and the economy with full cost pricing);
- the second one is the gathering and the integration of many theoretical paradigms in a comprehensive formal framework.

For instance, in land-use and transport modelling, the discrete-choice approach (“random utility model”) now widely adopted (de la Barra, 2001) as behavioural model for land use and allocation decisions (see TRANUS, MEPLAN, UrbanSim, CUF2, (Wegener, 1994) leaves room for a less strictly economical view of household motivations and decisions. It allows, for instance, integration of sociological, cultural or environmental consideration in the motivations underlying households’ location choice. Yet, the dominant paradigm of human behaviour still remains the strictly Homo oeconomicus which is possibly a dubious assumption with respect to household location and housing choices. See e.g. Allen (1997) or Portali (2000).

Likewise, few of these decision-support models takes into account the changes induced in land cover and ecological services by the interlinkage of human activities and biophysical processes, nor the impact of these changes on the utility of households.

In this respect, one observes that the EU has financed two important projects in the land-use and transport policy field: the SPARTACUS project and then the still ongoing PROPOLIS project. Their objective is precisely to improve the capacity of current tools in land-use and transport modelling to help defining policies leading to really sustainable cities, taking into account not only the economical but also the social and environmental dimensions of urban planning.

Uncertainty

Basically, uncertainty may result from two sources: the databases used by the tool and the knowledge of the system considered (formally, the nature and the estimation of the relationships). The solution for the former consists in sensitivity analyses. These analyses can be applied either on the coefficients or parameters of the system (e.g. price elasticity) or on the data themselves. These tests can be carried out locally (on a limited number of parameters) or globally (on the whole system). They can also be either deterministic or stochastic; in the latter case, a distribution of probability is required. In the best methodological case, these tests indicate the level of confidence associated with a result.

Depending on the discipline, such sensitivity analyses are more or less widespread or elaborated. Whatever methodology is used, it allows to identify the sources of uncertainty and to evaluate their impacts on the issue considered. As a matter of debate, uncertainty directly implies to associate the stakeholders to the decision-making process.

Even if this practice is not generalised enough, examples of the integration of uncertainty in tools or models are relatively numerous. The optimisation TIMES-MARKAL model uses stochastic programming to evaluate technological choices in energy systems. Levels of confidence are calculated for the indirect greenhouse gases emissions induced by meat products with material flows analysis and life cycle tools (Bréchet, 2001). In the field of land-use and transport policies, a tool such as UrbanSim (Waddell et al., 2000) which adopts a very disaggregated approach and can be coupled with a micro-simulation module for determining household and firms demands is more suited than others for dealing with uncertainty. The same holds true for multi-agent and cellular-automata based approaches.

Generally, the implications of irreversibility and thresholds are ignored and these shortcomings must be borne in mind. They represent two key dimensions in environmental issues and should really be taken into account in the decision-making process. From this point of view, one can notice that they are fundamentally associated to the precautionary principle (Perrings, 1991).

Long-term perspective

The methodological implications of the introduction of the long-term dimensions in tools and models are very complex. From a sustainable development point of view, long-term implies uncertainty, globality and interdisciplinarity (see the matrix above). In the energy field, the temporal dimension of the long-term is generally dealt with, notably concerning climate change (think of the DICE model of Nordhaus (2000) or energy forecasting), but if it is rarely integrated to other issues such as demand management (for example in the transport sectors).

Long term perspective is certainly one requirement where current land-use and transport modelling practices fare rather badly. For most of them, long-term begins with a 20 years time-span… This is mainly due to fact that they are generally static-equilibrium and not dynamic-disequilibrium models (UrbanSim is also an exception in this regard) and to the cross-sectional character of their databases and estimation procedures. Moreover, none of the models we know of takes the generation (demographic cohort) as point of departure for modelling population changes or households behaviour with respect to labour supply, housing demand, and migration.

The intergenerational equity dimension is generally ignored, except by some computable general equilibrium models. These models distinguish the different generations and the wealth transmission between them. They directly address the question of discounting and equity criteria. Hence, a real integration of the long-term dimension would consist in feedbacks between the future and the present. Of course, this raises the core question of the evaluation of wealth and welfare for each generation, which requires a strong theoretical framework. This explains, maybe, why so many tools and models are unable to cope with intergenerational issues.

Stakeholder participation

Ideally, integration of the various stakeholders in decision-making should take place at the different stages of the whole process. This means that the institutional setting in which the decisions have to be taken must provide for the participation of the various stakeholders from the very beginning to the end.

Stakeholders have a double role in decision-making. First, they are to be considered as "local expert", possessing valuable information and knowledge about the system or the problem at stake. The methodological problem here is how to collect, formalise and integrate this knowledge in the model. Classical survey methods and opinion polls are of course relevant here, but less classical tools as well such as the Delphi method, cognitive maps or some form of participatory methodologies.

Of course, there is more in stakeholder participation than just taking their opinion into account. If a simulation model is used as support for the policy making, the stakeholders should be, as much as possible, involved in the modelling process itself, in the definition of scenarios and hypotheses, and in the analysis of the various runs. What that means is that the principles on which the methodology is based must be, by and large, understood and accepted by them. Furthermore, it should be possible for them to "play" with the model, introduce their own hypotheses, run their own scenarios, etc. Finally, they should be able to grasp the outputs of the model. Obviously, all this will depend heavily on the "user-friendliness" of the decision-support system. It follows that a careful design of the user interface and help functions of such tools as conditions of their possible appropriation by laymen may be much more important that we are used to think about (Engelen et al., 1997).

Second, if stakeholders are to be involved in the implementation of the policy or simply endure its - maybe adverse - effects, they should participate in the aggregation and selection stage of the decision-making process. This opens the way to a more systematic use not only of multi-criteria or multi-attribute decision tools but also of collaborative decision-making methodologies (Paruccini et al., 1997), where even a consensus over the objectives has to be elaborated. One thinks here of methods such as consensus building conferences.

In sum, stakeholder participation asks for specific tools allowing collaboration in the definition of objectives and valuation of effects, but also for a better accessibility of the existing tools for naïve but concerned citizens. In that respect, the PROPOLIS project is interesting insofar as it plans to associate more closely policy-makers and users to the whole process of land-use and transport modelling and in policies definition and assessment. Recent developments in multi-agent modelling approaches also look promising in this respect.

From global to local and vice-versa

Admittedly, this is probably the most challenging demand from a methodological point of view. Although it cannot be equated with the micro-macro articulation problem, it may be considered as very close to it. Now the micro-macro articulation problem is still pending in social sciences (economics, geography, sociology) and, as Max-Neef argued, in development policies as well (Max-Neef, 1991). Climate change is the issue where this dimension has been the most effectively dealt with, albeit generally in a rather simple way: only from the local to the global and as local contribution to global warming. The debate between top-down and bottom-up models for energy issues is another example. Much more difficult is the analysis of the consequences of global change on local ecosystems and economies…

As far as we know, there have been very few experiences in hierarchical, multi-level model building. The “second report to the Club of Rome” (Mesarovic and Pestel, 1974) is an exception, still to be considered as one of the most ambitious and impressive achievement in what remains a fundamentally top-down approach.

The recent and rapid development of the multi-agent paradigm is very promising in that respect. By simulating populations of interacting agents in their environment, multi-agent modelling helps to understand how local processes can affect global or macro dynamics and, inversely, how these shape the environment in which each agent is living (Bousquet et al., 1999). Land-use and transport policy-making should certainly benefit a lot from it.

It must be stressed also that a satisfactory treatment of this issue doesn’t necessarily mean that every tool should cope with it in one way or another but rather that there should exist suitable tools at each level of decision and that these tools should be designed so as to permit communication between them. In land-use and transport policy, for instance, the available tools are way too heavy and costly for use at a small or even medium town level. Only the more important cities have the human and financial resources to make use of them. Tools are lacking for secondary towns and also for rural regions for which the theory of urban economics, on which the major models are based, is less relevant. For energy issues, the same problem appears since a large number of agents and levels are involved

Conclusion

There will be no more enlightened, responsible and democratic decision-making without more interdisciplinarity, long-term perspective, awareness of uncertainties and of scientific insufficiencies, widening of scope and scale of our models and a better communication between science, polity and society. Interdisciplinarity, specially, is of utmost importance if one want to deal adequately with the other criteria.

Indeed, there is something artificial in the separation between economics, history, geography, political science, sociology, demography, etc. They have grown separately, mainly for contingent historical, sociological and institutional reasons. Does it follow that "a necessary condition for unified policy-making is a unified social science" as Bunge (1998) put it? Maybe it is going too far but nobody would deny that there is an urgent need for more co-operation between disciplines, not only between social and natural sciences, but even between social sciences themselves, the same holding also for natural sciences.

Now, the best way to build a fruitful co-operation is by working together on policy oriented tools, trying to help our societies to solve real-world problems such as those brought by sustainable development. We guess that it is quite difficult to ignore the long term when working with historians, or the multi-level dimension of economies and societies when sitting beside geographers, or the need to communicate and discuss with stakeholders with sociologists looking over your shoulder…

So, if taken seriously by scientists, sustainable development issue may also constitute an extraordinary opportunity of building a more integrated, co-operative and open-minded scientific community.

In sum, if sustainable development needs science, it is quite possible that science needs sustainable development as well.

References

Allen, P.M. (1997), Cities and Regions as Self-organising Systems, Gordon and Breach Science Publishers.

Atkinson, G. (2000), Sustainable development and policy, in: Helm D. (ed.), Environmental Policy: Objectives, Instruments and Implementation, Oxford University Press, pp 29-47.

Bousquet, F., Barreteau, O., Le Page, C., Mullon, C., Weber, J. (1999) An Environmental modelling approach. The use of multi-agents simulations. In: F.Blasco, A.Weill (Eds.), Advances in Environmental and Ecological Modelling, Elsevier, Paris, pp 113-122.

Bréchet Th. (2001), Greenhouse gases emissions reductions and material flows analysis, Research report to the OSTC (http://www.belspo.be) Bunge, M. (1981), Development Indicators, Social Indicators Research, 9: 369-385.

Bunge, M. (1999), Social Science under Debate, University of Toronto Press, Toronto.

Dale, C.J. (1986), Introduction to Database Systems, Addison Wesley.

De la Barra, T. (2001), Une approche intégrée de l'aménagement du territoire et de la planification des transports : la voie à suivre pour l'Europe, IPTS Report, N°51, février-mars, pp 14-21.

Dasgupta, P., Mäler, K.G. (2001), Wealth as Criterion for Sustainable Development, Discussion Paper 139, Beijer Institute of Ecological, Economics, Stockholm.

European Environmental Agency (2000), Cloudy Crystal Balls – An Assessment of Recent European and Global Scenarios Studies and Models, Environmental Issues Series, n° 17.

European Union Commission (1998), SPARTACUS: System for Planning and Research in Towns and Cities for Urban Sustainability, DGXII, Brussels.

Ekins, P. (2000), Costs, benefits and sustainability in decision-making, with special reference to global warming", Int. J. Sustainable Development, Vol. 3, n° 4, pp 315-333.

Engelen G., White, R., Uljee, I. (1997), Integrating Constrained Cellular Automata Models, GIS and Decision Support Tools for Urban Planning and Policy Making, in: Timmermans H.P.J. Decisions Support System in Urban Planning, E&FN Spon, London.

French, S. (1988); Decision Theory. An introduction to the Mathematics of Rationality, Ellis Horwood Limited. Chichester.

Funtowicz, S.O., Ravetz, J.R. (1990), Uncertainty and Quality in Science for Policy, Kluwer Academic Publishers.

Godard, O. (1993), Le développement durable, in : Commissariat général du Plan, L'économie face à l'écologie, Editions La Découverte, pp 132-143.

Handmer, J.W., Norton, T.W., Dovers, S.R., eds. (2001), Ecology, Uncertainty and Policy, Prentice Hall, London.

Munasinghe, M. (2001), Sustainable development and climate change: applying the sustainomics transdisciplinarity meta-framework, Int. J. Global Environmental Issues, Vol 1, n° 1, pp 13-55.

Paruccini, M., Haarstrup, P., Bain, D. (1997), Systèmes d'aide à la décision au service des responsables de l'action publique, IPTS Report, N°14, pp 33-41.

Perrings, C. (1991), Reserved Rationality and the Precautionary Principle: Technological Change, Time and Uncertainty in Environment Decision-Making, in: Costanza, R. (ed.), Ecological Economics: The science and management of sustainability, Columbia University Press, New York.

Portugali, J. (2000), Self-Organisation and the City, Springer.

Van den Bergh, J.C.J.M., Hokes, M.W. (1998), A survey of economic modelling of sustainable development, in: van den Bergh, J.C.J.M., Hokes, M.W. (eds), Theory and Implementation of Economic Models for Sustainable Development, Kluwer Academic Publishers, pp 11-37.

Van der Vorst, R., Grafé-Buckens, A., Sheate, W.R. (1999), A systemic framework for environmental decision-making, Journal of Environmental Assessment Policy and Management, Vol. 1, n° 1, pp 1-26.

Waddell, P. (2001), UrbanSim : Modelling Urban Development for Land Use, Transportation and Environmental Planning, Journal of the American Planning Association, forthcoming.

Walliser, B. (1977), Systèmes et Modèles, Editions du Seuil, Paris.

Wegener, P.M. (1994), Operational Urban Models: State of the Art, Journal of the American Planning Association, 60(1), pp 17-21.

The challenges and limits of existing scientific tools for underpinning a Sustainable Development policy

Peter Hardi

International Institute for Sustainable Development, Canada
161 Portage Avenue East, 6th Floor
R3B 0Y4 Winnipeg Manitoba
Canada
Email: phardi@iisd.ca

Introduction

There is a wide spectrum of scientific tools to support decision-making in the context of sustainable development (SD). These tools include concepts and techniques from many different disciplines. Several of them can be grouped as assessment and measurement tools. The U.S. National Center for Environmental Decision-Making Research (NCEDMR) categorises tools for decision-making as:

1. Bits of information or data, both quantitative and qualitative. e.g. measurement or observations of environmental conditions, or socio-economic conditions and of regulatory conditions.
2. Tools to gather data, e.g. physical scientists use such tools as pH meters, vegetation surveys and atmospheric tests, while social scientists use surveys, interviews and systematic investigation of public records.
3. Tools to organise and analyse data, including models that describe relationships among units of information, e.g. conceptual tools such as taxonomy, mathematical tools such as statistical analysis, GIS, simulation models, forecasting tools, assessment (including risk assessment, cost benefit analysis). (NCEDMR 2001)

The recipe for applied measurement (and the tools of measurement) is linked to different, supplementary theories that explain how the tools (instruments) work. This creates an operational connection to the models that has no purely mathematical formulation. I'll focus my analysis on the connections between 1. and 3. above. I will describe models and conceptual frameworks in the context of measurement tools and categorise these tools according to the conceptual frameworks that they rely on. I will also analyse the lessons learnt from our field projects and the links to decision masking.

SD is a relatively new social goal, one, which has to become part of mainstream political and economic debate. Societies measure what they care about, and measures of SD contribute to the acceptance and legitimisation of important social goals. Measurement helps decision-makers and the public to define social goals, to link them to clear objectives and targets, and to assess progress toward meeting those targets. It provides an empirical and quantitative basis for evaluating performance and connecting past and present activities to attaining that future goal. Measuring SD - just as we currently measure economic production - makes it possible for this complex social goal to become part of the mainstream political and economic debate.

Summary of main findings

The main findings of our research and fieldwork at IISD are as follow:

1. Because there is no well established or generally agreed upon theory of sustainability, and SD is not a scientific discipline (despite efforts describing it as such), its measurement is either eclectic or the derivative of another scientific discipline(s). This is particularly true for data generation and processing, but also holds true for modelling.

2. Conventional models or frameworks do not apply to SD for its non-linearity and multiple cause-multiple effect relationships. For the same reasons, most of the statistical and econometric analytical techniques are not helpful. I'll provide a quick review of the limitations of these techniques based on our empirical findings.

3. There is a general tendency in post-normal science to redefine the characteristics of scientific inquiries. SD is a point in case, as it raises the need for considering co-evolutionary and participatory processes and ethical/equity considerations as inherent components of a new scientific inquiry. Empirical evidences from our field projects will be offered.

4. Best conceptual frameworks to measure SD are linked to a holistic approach; these frameworks are based on eclectic use of existing models and seldom develop a genuinely new model. Complexity of SD requires multiple descriptions, as no single model captures the dynamics of ecosystem and human system interaction. A classification of the measurement frameworks will be presented.
5. With all these limitations in mind, an available degree of mathematical and econometric precision is still a missing element in interpreting data; linkage analysis is a crucial part of a less subjective interpretation of results.
6. SD measurement tools are particularly sensitive to scale considerations. Scales limit the applicability of models and scenarios. Aggregation across spatial scales and sectors defines a specifically difficult task. It raises the issue of a standard measurement framework (or the lack of it), the use of performance scales and the reference to targets.
7. There is a rationale behind the separation of presentation format from the actual content and scale of the measurement. A presentation tool that is not dependent on a specific SD measurement concept or model can be a significant step in achieving an international consensus on the use of a standard measurement technique.
8. There are a series of interlinked decision-making strategies that define measurement regimes, only few of them depending on science. For example, one of the strategies deals with linking measurement presentation tools to communication. A short demonstration of a promising new visually engaging presentation tool that connects well with decision-makers will complement the presentation.

Illustration of findings I: measurement frameworks

As in every survey, classification emerges as an important task to help orient an interested audience that wants to make good use of the many examples offered. Classification also helps in identifying the scope and limits of our current knowledge and in reviewing the available methods. The real significance of classification is that it does more than group different methods and measurement projects for convenience: it helps select the most adequate format and methods of measurement. Classification is based on common features of the individual examples; there is always, however, more than one set of common characteristics, so there is more than one way to classify measurement and indicator projects. The two most frequently applied classifications of SD indicator works are by the scope of the measures, that is, by the type of media they cover, and the spatial units the measures cover. SD indicators can be classified in other ways (see Hardi 2001; Bell and Morse, 1999; Rechatin et al., 1997). A frequently used classification distinguishes performance from system indicators, referring to the difference between measuring success in achieving set targets and measuring the actual state of the human and natural environment. This, however, is a general classification principle, not one specific to SD indicators. Though several practical approaches present mixed sets of indicators, the survey deals with frameworks applied to what are called system indicators in the former sense.

In any measurement project, one of the first tasks is the definition of a framework to focus and clarify what to measure, what to expect from measurement, and what kind of tools (indicators) to use. The framework is the most direct reference to the underlying concepts of SD that define the measurement process. For this reason, conceptual frameworks are selected as the basis of classification for the SD measurement and indicator projects reviewed in this survey.

A *framework* is a conceptual model that helps select and organise the issues that will define what should be measured by indicators. Conceptual models, even without truly capturing the real world, the complexity of which is beyond current knowledge, also provide a mechanism against which the real world can be set to facilitate learning. This comparison often leads to constructive tension, debate and, eventually, to the accommodation of different interests and values. The sought-after result is improved decision-making.

The main differences among frameworks are:

- The ways and means by which they identify measurable dimensions, and group the issues to be measured; and
- The concepts by which they justify the selection of indicators.

The application of a framework is not always explicit. While several measurement initiatives start with the description of their conceptual framework or their model, many of the approaches do not even speak about conceptual framework. It leaves the reviewer with the difficult task to group different initiatives into frameworks that are not custom tailored. Yet, from an analytical perspective, all measurement and indicator works can be grouped to one or more of the existing conceptual frameworks. In the following section the most influential frameworks will be briefly introduced and illustrated by existing practical initiatives.

The analysis will follow a simple guideline related to a major challenge in measuring progress toward SD: the challenge of a *holistic approach*. A holistic view requires analysing not only the otherwise very complex ecosystem and human system (including its social, political, economic, institutional and cultural components) by themselves, but also their interaction. The interaction often amplifies the complexity of issues and creates a combination of obstacles for those who try to manage and/or measure this interaction. Yet the attempts to capture this complexity are considered essential, and the frameworks will be grouped according to the extent they succeed doing it. In other words, the organising principle is the inclusiveness of the frameworks: How many essential elements of SD do they cover while measuring progress toward it? To this end, the analysis is based on the recommendations of the Bellagio Principles of Assessment (Hardi and Zdan, 1997), in particular principles 2 and 3. (See also at IISD 2002)

It is a historical curiosity that the earliest SD measures have been based on the least holistic frameworks. The first practical attempts to measure some aspects of SD were based on traditional environment reporting. The historical trends, with some simplification, show progress from amending existing indicator (environmental or economic) sets through combining two or three separate types of indicator sets (like environmental and economic, or environmental, economic and social indicator sets, respectively) to developing an independent SD indicator set or index. The survey of the frameworks will follow this logic, giving priority to approaches that are based on actual data sets.

Environmental frameworks: Amended environmental indicator sets

Although several theoretical possibilities exist for amending existing indicator sets—such as environmental indicator sets amended by economic and social indicators; social indicator sets amended by economic and environmental indicators; and economic indicator sets amended by social and environmental indicators—only one has practical significance. Amended environmental indicator sets were the first ones presented as efforts toward a set of SD indicators.

The underlying logic, when using conventional state of the environment indicator sets for SD indicators, is that sustainability is principally an issue of ecosystem and natural resource conservation, the preservation of the life-support capacity of the ecosystem. SD indicators have been identified when using ecosystem sustainability indicators. As the perception of SD shifted to include more social issues, several economic and social indicators were added to the list. In this approach the standard environmental reports and their indicator sets are used with little addition to capture some extent of SD. Even a term was coined, *'socio-economic environmental indicators,'* to indicate the added measurement issues (Bakkes et al., 1994). Usually, some economic and social indicators are added, particularly to cover income generation, employment, health and education issues as well as the impact of some sectoral activities, such as agriculture, transportation, and tourism. The additions are not based on any particular conceptual framework of SD; they are based implicitly on the idea that SD measures must include social and economic indicators as well. In this sense the efforts present an *eclectic selection*.

Some of the best-known examples are different national reports (Australia; Canada; Finland; France; New Zealand, etc.); OECD's environmental indicator set (OECD 1998);

The European Environment Agency's and EuroStat's environmental pressure indices (European Commission and EuroStat 1999); UNEP's Global Environmental Outlooks (GEO1997 and 1999); and recently the World Economic Forum's Environmental Sustainability Index (WEF 2000).

Synthesis of environmental and economic frameworks

The most prominent and theoretically enriching efforts to create SD indicators by combining two separate types of indicator sets are those known to amend economic indicators with environmental and/or social indicators. Initially, most of these efforts had been contested by mainstream economists who wish to maintain the theoretical rigour and the clarity of economic methods by which economic indicators are defined and measured. As there are no simple additions to economic indicators without specifying the relationship or hierarchy between economic and other priorities, most of these efforts have a deep impact on economic theory and the conceptual clarification of SD. Much of this thinking led, in the 1980s, to the new field of ecological economics.

A large number of economic measures are regularly used worldwide by decision-makers both in the public and private sectors and are reported daily in print and electronic media. At the same time, particularly after the Earth Summit in 1992, it has also become politically acceptable to acknowledge that economic measures provide an incomplete picture of welfare and development. The international debate has resulted in many suggestions to improve the use of economic indicators by capturing dimensions they usually do not cover. Many of these efforts stayed within the logic of conventional economics.

The *materials and energy balanced model* describes the relationship between pollution and economic activity. The model considers the environment as a large shell encompassing the economic system, providing sustenance and carrying away waste. Raw materials flow from the environment and are converted into consumer goods. The household sector receives at least a fraction of these goods. Wastes resulting from the household sector’s consumption activities and production flow back into the environment.

Most efforts to design indicators that capture the logic of material and energy flows use material dimensions as measurement units (such as tonnes) to characterise the input-output flows. Early examples of indicators based on the materials and energy balance model are the Material Input Per Service Unit (MIPS), developed by the Wuppertal Institute for Climate, Environment and Energy in Germany (Schmidt-Bleek 1994. A more recent effort is the calculation of Total Material Throughput (or Total Material Requirement) Indicators by the World Resources Institute, in collaboration with the Wuppertal Institute, the Dutch Institute for Public health and the Environment, and Japan's National Institute for Environmental Studies (Adriaanse 1997).

A variation of the depletion-pollution models is the *Ecological Footprint* (EF). The EF model (Wackernagel and Rees, 1996) is an accounting tool that calculates the productive land area required to sustain resource consumption and waste assimilation requirements for a defined human population or economy. It is endorsed by many researchers and local initiatives. It measures the virtual amount of land an entity (person, city, nation) requires for the maintenance of its life, in a single aggregate index. For example, Rees calculates that Vancouver, through its food, water, energy and waste-disposal demands, actually occupies an area of land (an ecological footprint) 14 times the nominal area of the city. (Like similar material-flow-balance models the EF only considers the effects on the environment of economic decisions with regards to resource use). The ecological footprint is a function of population and per capita material consumption. The model assumes that all types of energy, material consumption and waste discharge require the productive or absorptive capacity of a finite area of land and water, and calculation of the model requires incorporation of relevant income, prevailing values, socio-cultural factors and technology for the area under study.

Accounting models: Corrections to the System of National Accounts

The international debate has contained many proposals for bringing the elements of environmental, social and institutional wealth into the System of National Accounts to complement the measures the economic wealth in a society (World Bank, 1993; Bringezu et al., 1994). In the SNA, transactions should be measured by market prices and/or a real flow of money. In recent years, considerable efforts have been made at the international level to promote the integration of economic and environmental accounting and to develop methodologies in this area. Current work concentrates in four main areas: adjustments to the SNA, creation of satellite accounts, creation of specific national resource or environmental accounts, and creation of environmental accounts at the micro level (UN DPCSD, 1996). These experiments are not to create new indicator sets. Rather, they use existing indicators in a new context. Strictly speaking, these are not indicator but “measurement” approaches. The SNA is not an indicator set; it is a *convention*, a system that is negotiated and accepted by international consensus.

Conventional economics deals with the allocation of scarce resources for production or consumption. This allocation is primarily through transactions expressed in terms of stocks and flows. The environment is not included in the system but rather is treated as external to all analysis or models, even though the environment and the economy are highly interdependent. Green accounting is viewed as a straightforward remedy for this dilemma since it integrates environmental and economic data and analytical variables. Yet, there is no international consensus on how to incorporate environmental assets and the costs and benefits of their use into the internationally adopted SNA. Different approaches could be adopted in three areas: the attribution of environmental degradation, identifying environmental protective activities, and valuing both sets of activities.

Bartelmus (1993) noted that economic accounting does not cause environmental problems and thus the solution is not environmental accounting. (Accounts are merely records of past events and facilitate decisions. They do not make decisions.) As a bridging solution, the United Nations Statistical Division developed its System of Integrating Environment and Economic Accounting (SEEA) in 1993. The SEEA focuses exclusively on the relationship of economic and environmental (mostly biophysical and resource) issues; human and social dimensions are not included. Further development of resource inventories as well as “sensitivity mapping” of natural resources is needed in order to identify areas of high risk or vulnerability.

Green GDP

The abundant literature on “Green GDP” mirrors the desire to contrast the enormous power of GDP with measures “taking nature into account” (also the title of a report to the Club of Rome, van Dieren, 1995). Green GDP is the informal name given to national income measures that are adjusted for natural resource depletion and environmental degradation. The calculation is based on the assumption that a logically consistent aggregate measure of economic well-being needs to include the cost of externalities such as exploiting natural resources, and the social costs of pollution discharge. Further expansions of the green GDP idea include into the calculation other non-marketed activities such as household and volunteer work. The best-known examples are the Genuine Progress Indicator (GPI) (Cobb et al. 1995) and its predecessor, the Index of

Sustainable Economic Welfare (ISEW) (Daly and Cobb 1994). The ISEW has been calculated for several countries already. These efforts stay within the economic input-output frameworks and use monetised units as the dimension of measure.

New model-based approaches

If the indicator selection is based on a conceptual linkage among the key issues of SD, we had better speak about a model-based approach. Most of the models use systems theory approach, whether they explicitly refer to it or not. In the most general terms, two systems are distinguished (the human system and the encompassing ecosystem). But for specific models the economy and social institutions are regarded as a system. (Nilsson 1995). In some models, the focus is on one of the systems: either on ecosystem qualities that restrict the analysis to one of the systems, or on human system qualities that - in case of quality of life approaches - leads to an eclectic presentation.

Indicators as measurement components of holistic systems can be *status indicators*, *change* (or dynamics) *indicators,* or *systemic* (or evolution) *indicators.* Some researchers use a hierarchical framework of indicators. The essence of the hierarchy is a structure of consecutive levels of aggregation, from data and statistical information, to single indicators, to indices, to subsystem aggregated indices (Rotmans 1997). Other examples of holistic indicator use include the EuroStat approach (EuroStat 1999) and Dashboard of Sustainability developed by the Consultative Group on Sustainable Development Indicators (Consultative Group 2000). A few of the better-known model-based frameworks will be commented:

- Pressure-State-Response model and its variations
- Human system–ecosystem well-being models
- Capital-centred and stocks-and-flows models

Modified Pressure-State-Response models

This framework was originally developed by Rapport and Friend (1979) in Canada for environmental statistical purposes. Its first practical application was in OECD's environment reports from the early 1990s (OECD 1991 and 1993). Many national state-of-the-environment reports, including that of Canada, adopted the same framework.

A modified version of the framework, the Driving Force/Impact/State/Response framework, has been adopted by the UN Commission on Sustainable Development (UN CSD 1996). It is offered to national governments to measure their progress in implementing Agenda 21, the set of recommendations from the UN Conference on Environment and Development in 1992. This is the most ambitious and widespread program to date with a commonly shared set of traditional indicators to assess SD performance. It has moved beyond the initial stage of developing a set of indicators and is already in the testing phase. Where applied, it enjoys the official support of national governments.

Despite its explicit reference to the application of the DF/S/R framework, the selection and grouping of the indicators and the thematic clustering around Agenda 21 chapters is clearly an eclectic approach. The UN CSD indicator set has included 134 indicators. The high number of indicators made the set unfit for decision-makers and, since there is no attempt at aggregation, it does not provide a measure of progress. With the support of an independent consultant from Pricewaterhouse Coopers, UN DSD had performed by the end of 1999 a critical assessment of the experiences when testing the indicators of the CSD. Based on the findings, recommendations were made to focus present efforts on shortening the list of indicators, creating a set of 56 core indicators, promoting aggregations of indicators, and following a thematic organisation of the indicators along the four basic themes of economic, social, environmental and institutional indicators, instead of rigidly grouping them according to the chapters of Agenda 21. (UN DESA, 1999)

A serious limitation of the approach is the DF/S/R model itself. It does not work if scientific evidence for causal links is missing, and it oversimplifies inter-linkages and relations among issues. Often, it is ambiguous whether the issue measured by an indicator represents a driving force or a state. For example, unemployment (measured by unemployment rates as an indicator) might be considered a driving force triggering policy responses or a state that reflects the impact of a wrong economic policy. Also, there are multiple pressures for most states, and multiple states from most pressures. For example, sulphur dioxide causes not only acid rain but also urban air pollution; fish populations are affected not only by fishing, but also by pollution and weather, and perhaps global warming. Furthermore, a change in one fish population, by altering nutrient availability or competition patterns, will change another fish population.

Human system–ecosystem well being models

Between 1991 and 1995, the Task Force on Sustainable Development Reporting of the NRTEE examined the ability of Canadians to monitor, assess and report on progress toward SD and addressed long-term issues of the conceptual and theoretical complexities of reporting. It defined a new, whole-system approach to a set of indicators that captures the values implied by SD, particularly a parallel concern and respect for the ecosystem and the people within, constituting a whole (NRTEE, 1995). The approach emphasises four main areas of assessment:

– the integrity and well-being (or health) of the ecosystem;
– the well-being of people defined in the broadest sense (including individuals, communities, nations, etc.) and the assessment covering physical, social, cultural and economic attributes;
– the interaction between people and the ecosystem (how human activities stress or restore the ecosystem, how successful humans are at meeting policy goals and objectives); and
– the synthesis of the above three components and the links across them.

The best known application of this model is the Barometer of Sustainability. The *Barometer of Sustainability* (Prescott-Allen, 2001; IUCN-IDRC, 1997) assesses a region's progress toward sustainability through the integration of economic, biophysical and social health indicators. Development of the Barometer of Sustainability scale requires people to state explicitly their assumptions about human and ecosystem well being so calculated sustainability ratings can be scored against desired levels. The Barometer of Sustainability is a combination of ecosystem and human well being, each measured individually by its respective indices. Indicators for these indices are chosen only if it is possible to define them in numerical terms. The values are projected to a performance scale. The projection, however, is arbitrary and occasionally missing. Within the selected dimensions, too many indicators are presented, making a concise evaluation difficult.

Capital and stock/flow based approaches

The World Bank's measure of the Wealth of Nations

Although classical economists recognised the importance of land, labour, and capital in explaining economic growth and national wealth, in the post-World War II period national well-being has been measured by the GDP or the GNP (GDP plus net factor income from abroad). Countries were ranked by their level of GNP per capita, and few questions were asked about the underlying resource base for GNP growth and whether it was sustainable.

In 1995 the World Bank started experimental work to monitor progress in environmentally SD (World Bank, 1995, 1996). The Bank has attempted to measure the wealth of nations by measuring natural resources (the natural capital) relative to produced assets (or human-made capital) and human resources (the social and human capital). The approach presumes that SD is a process of creating and maintaining broadly conceived wealth. The notion of wealth is extended from natural and produced wealth to human and social capital (World Bank 1997). There is a stock of health, skills and knowledge contained within human beings that can be invested in, enhanced, and used to produce a steady stream of productivity, or that can be overused, eroded and allowed to depreciate. There is also an equivalent social capital in the form of law and order, functioning civic organisations, cultures of personal and community responsibility, efficient markets and governments, tolerance and public trust.

The approach uses aggregation and monetisation to compare data and rank nations according to the cumulative value of their capitals. Capitals are measured through a number of indicators, mostly taken from the realm of integrated economic and environmental accounting. (Kunte et al., 1998)

- Natural capital is measured through six components: agricultural cropland, pastureland, timber, non-timber forest benefits, protected areas and non-renewable materials (metals, minerals, oil, coal and gas).
- Human-made capital or produced assets are measured in the categories of fixed capital formation, including machinery and transport equipment, building and construction, and urban land.
- Social capital is measured along relationships and institutions of a society (horizontal associations such as the number and type of local institutions; civil/political society such as the index of civil liberties; social integration such as social mobility or crime; and legal/governance aspects such as the independence of the court system) and the types of impacts social capital has on the development process (growth, equity and poverty alleviation).
- Human capital is measured along acquired skills (e.g., education) and health (e.g., life expectancy).

Indicators have been selected to represent the above categories in a way that monetised values could be assigned to each indicator. Trends are measured by genuine savings as a percentage of adjusted gross national product (where adjustment includes depletion of natural resources and damage caused by pollution as minuses, and spending on education as a plus).

The framework offers a holistic approach and puts a major emphasis on the links among the main dimensions of progress and the complementary character of these dimensions. It offers a new model for economic development: development as portfolio management, the process of transforming an endowment of assets in order to achieve development objectives. Extending the definition of capital to natural, human and social capital is an easily understood and powerful concept that could link sustainability and development, and provide a dynamic, whole-system approach. The concept of capital allows the stock-flow analysis that can make indices dynamic. It is future-oriented, deals with trends and has clear policy relevance. It is pioneering in defining indicators for social capital, taking into account the institutional structures and accumulated experience of communities. It offers a harmonised calculation method, expressing the indicators in comparable monetised terms, and makes aggregation easy. The methodology is based on the balance-sheet calculations of national accounts, providing understanding for key economic policy-makers.

The approach, however, applies several innovative ideas that are not well tested yet. The concept of social capital, in particular, needs further refinement and better dimensions for measurement. The methodology focuses entirely on monetised values and only measures those segments of SD that can be expressed in monetary terms. Indicators are not presented in matrix format, and the structure of presentation is not transparent. The detailed calculations of indicators are highly technical and difficult to handle.

The U.S. SDI Working Group's set

The SD Indicator Working Group (earlier called the Inter-Agency Working Group on SD Indicators, reporting to the President's Council on SD) elaborated a framework (see US Inter-Agency Working Group 1998 and http://www.sdi.gov/) in which they have grouped indicators into three categories:

1. Endowments (forms of capital or wealth, and liabilities)
2. Driving forces and processes (forms of saving/investment or dis-saving/depreciation)
3. Current Outputs and Results (goods and services used; value derived by satisfying needs and wants.)

One of the most attractive features of this framework is the well-defined relationship each of these categories has to the concept of sustainability. (They broadly rely on the Brundtland definition of SD). For example, Endowments are the stocks and capacities that the current generation can draw upon to meet its needs and wants and that it passes along to future generations, providing them the opportunity to meet their needs and wants. The framework also includes Liabilities, which are stocks or capacities that will impose costs on future generations.

The relationship between Endowment measures and SD, by the framework's architects, is "the more the aggregate measure of endowments shows that the capacity of our endowments to contribute to meeting human needs and wants is being maintained or increased, the greater the sustainability of our current system." If endowments are being maintained, then the opportunities for future generations to meet their needs are not being compromised.

Canada's ESDI project

The Environmentally Sustainable Development Indicator project, also called the "Budget Initiative", as it was announced in the spring of 2000 in the new budget speech of Canada's minister of finance, is the government's effort to help develop a few highly aggregated indices that could influence top level decision making together with the leading economic indices. The government allocated CAD 4.5 million to develop a Canadian information system for the environment (CISE) and another CAD 4.5 million to develop the ESDI. The executing agency is the National Round Table for the Environment and the Economy (NRTEE), see NRTEE 2001 and http://www.nrtee-trnee.ca/eng/programs. The indicator framework has been discussed in a national consultation process; the six clusters of the indices are drafted by technical advisors and expert groups.

The project is a capital-based approach; it will measure stocks and flows, based on resource accounting techniques and it plans to use monetary as well as physical valuation of different forms of capital. The project's underlying concepts includes the following:

- Economic production (production of goods and services within and outside the market place) is a function of produced capital, human capital, and natural capital;
- Natural capital is an important factor of economic production and includes natural resources, land, ecosystems;
- In order to benefit future generations it is imperative to maintain these capitals over time;
- Maintenance of capital include investment, restriction in use of natural capital or finding substitutes;
- Trade-offs between different forms of capital is allowed.

The project will be completed by the summer of 2003.

Illustration of findings II: Methodological assumptions to develop SD indicator systems

Even in an ideal case of complete agreement on the definition and interpretation of SD concepts or the use of a framework, some methodological issues, including procedural and institutional ones, confront measurement projects.

The importance of a strong conceptual basis

The lasting success of any SD indicator set requires that the indicators be clearly and logically related to sustainability. Aggregate indices of SD should be more than just the sum of a set of measures linked to important current issues, or things that people think are needed for a good life. They need to be sufficiently general to encompass current issues, without being subject to the changeable winds of political fashion.

SD is a process that will also shape the future of our social and economic systems. It is not a short-lived program designed to address only today's issues. Indices that are merely aggregations of measures for today's high priority issues will not provide a stable, meaningful statistical series over the long run. Either the issues comprising the aggregate will change, making it difficult to compare over time, or the index will become less relevant.

Each of the measures to be aggregated into an index should have the same conceptual relationship to sustainability. Furthermore, the conceptual framework should stimulate and allow the incorporation of additional measures without changes in the overall structure of the indices. Ideally, each measure would have the same relationship to sustainability in all countries and in all situations. Even if we cannot achieve this ideal in the short run, we need to assert it as a goal we are working toward.

Conceptual consistency is important because without it, the resulting indicators will not be robust. If the various measures do not have a conceptually consistent relationship to SD, it will be too easy to combine measures in other ways that are just as defensible, but give different results. In our society at least, little information goes unchallenged by those who stand to lose if it is regarded as being right. Information is always put to the test of criticism and counterclaim. An important aspect of producing information that can survive critical tests is to ground it in concepts and methods that have or will gain wider support from scientific circles as well as opinion leaders.

The importance of a sound methodology

The complex problems of SD require either integrated or interlinked sets of indicators, or aggregations of indicators into indices. The use of such sets raises two separate but linked methodological issues.

- Aggregation of data. This refers to the question of how to aggregate variables expressed in different units of measurement (e.g., different physical entities, or in more complicated cases, physical and social entities) or presented in different time series and referring to different spatial units. In principle, aggregation is not a mathematical average of combined data but a weighted average of individual data. Weighting, however, is a value judgement, attributing higher importance to certain data than to others. The principles of weighting need to be properly justified.
- Creation of *composite indices*. Creating measurement techniques for simple characterisation of policies and activities, using as few indicators as possible, is an operational problem. Composite indices are necessary because of the integrative perspective of SD. The problem of these indices is that the combination of data is frequently arbitrary.

Aggregation and the use of composite indices are important to make valid judgements on, and/or comparisons among, major trends of SD policies. The applied techniques need to include standard statistical and econometric methods as well as some of the more advanced methods developed for the analysis of fuzzy sets, contextual information and digital data (Pearce, 1999).

The importance of a strong data basis

One of the most pressing methodological issues that a measurement project must face is the need for an independent information database for cross-country, comparisons over time (data with adequate spatial, sectoral and temporal coverage); and the need for extended statistical and monitoring capabilities to collect and verify data. Related institutional and policy issues help create the necessary conditions for satisfying data needs. Some of the most important institutional issues are the following:

- Securing the independence (reliability) of data-collecting institutions;
- Securing the availability and dissemination of data nationally and internationally;
- Creating funds to cover the costs of measurement and data processing; and
- Being accessible to governmental and non-governmental users.

The data must constitute the foundation of an information system.

The importance of linking indicators to the policy process

Yet some of the greatest difficulties a measurement project faces are not what and how to measure but how to interpret measured data and judge the significance of the particular information. The interpretation of measures is affected both by the frameworks and the methods, but the ultimate result will depend on how the measurement process is applied in decision-making. Some measurement projects, however, simply provide an inventory of indicators without using them to link policies and actions to outcomes or setting clear standards against which policies can be evaluated.

Illustration of findings III: the use of metaphors

It is well known that indicators are also communication tools, and a communication strategy is needed to reach the target audience that should use the indicators. There are several techniques to make that strategy more effective. One of them is the use of metaphors in presenting indicators and measurement tools in general. Metaphors help simplify system characteristics, help focus on characteristics important from SD perspective, make communication much easier and help provide visually engaging tools. Metaphors can also be used in on-line presentation and Internet connections.

At the same time, there are challenges in the use of metaphors. These popularised presentations need to be translated to decision-making tools during which complex messages will be comprised in a catchphrase or in a single image. This, however, will require both the “zipping” and the “unzipping” of information. The most important question is this: How to put serious science behind the design?

An example: the dashboard of sustainability

The Dashboard is a visually-engaging, online tool designed to be understood by experts, the media, policy-makers and the general public. Using the almost universally-recognised image of an instrument panel, it displays the primary dimensions of sustainability and provides both quantitative and qualitative information about progress toward (or away from) sustainability. The Dashboard allows presentation of complex relationships in a highly communicative format.

The Dashboard emphasises the importance of thinking about the entire system. Conceptually, it is a set of aggregates of various indicators within each of the broad clusters (economic, environmental and social) represented by the dials of the dashboard. Each dial is an aggregate of several indicators displayed as coloured wedges. The colour of the indicator tells the story: Shades of green indicate the most positive or sustainable conditions; yellow is neutral; red is an urgent warning of non-sustainability in an area. The effect is an easily-understood gauge of a country's sustainable development performance and a demonstration of how it compares to other countries.

The Dashboard is also a communication tool that can provide useful guidance to policy makers and the public. Even ordinary citizens can get a quick assessment of the weak and strong points of their communities or businesses compared with other communities or businesses in the same "league" (i.e., provinces, municipalities, small communities, enterprises). Currently, over twenty different indicator sets have been "translated" to Dashboards, and the software becomes more and more a standard way of representing indicator sets, and several index developers are using it already in much the same way as they would use Word or Excel for editing their documents.

The Dashboard has been developed by an international team of measurement experts, the Consultative Group on Sustainable Development Indicators. The Dashboard is powered by unique software that can be accessed through http://iisd.org and at http://esl.jrc.it/envind/dashbrds.htm.

The international Dashboard application provides an empirical foundation for all efforts to assess progress toward sustainable development. Through its earlier development the Dashboard has generated increasing interest in its utility as a measurement and predictive tool. The Dashboard of Sustainability has garnered the attention of the UN Commission on Sustainable Development and displays the United Nations' core set of sustainability indicators. Additionally, European Union countries have expressed interest in contributing data at the regional, country and community levels.

Features of the dashboard

The Dashboard turns complex array of information into a simple graphic presentation. It visualises and tracks progress through colour coding from deep green to deep red, aided by also colour coded Internet and satellite linked maps. The dashboard presents different issues simultaneously; it makes linkages between indicators through distribution analysis. The correlation of any pair of indicators is shown graphically, using scatterplot analysis. There is a built-in flexibility for individual application of the Dashboard; its clusters can be modified, the weights can be adjusted according to the user's need. It is also interactive and provides instant links to web sites. It is multi-lingual, and most recently it makes trend analysis possible.

Further lessons learnt from fieldwork

Indicator experts need to develop tools to promote the dialogue between science and policy-making. In developing and applying these tools there is an increasing importance of the participatory process: It defines the research agenda as well as the priorities to be measured; and it helps review results and provide feedback to the refinement of tools.

The role of international consensus-building in the measurement process will gain new prominence. Efforts to standardise the measurement tools and the reporting process (like the

Global Reporting Initiative) are good examples of the increased understanding of the significance of an international consensus.

Finally, it is crucial to look beyond measurement: Integrated assessment systems, scenarios and models are also important tools in influencing the policy making process to achieve progress toward SD.

In lieu of conclusion: challenges and questions for future work

Measurement is particularly useful for decision-makers because it helps them understand what SD means in operational terms. In this sense, measurement and indicators are *explanatory tools*, translating the concepts of SD into practical terms. Second, measurement helps decision-makers make policy choices to move toward SD. Measurement and indicators create links between everyday activities and SD. Indicators provide a sense of direction for decision-makers when they choose among policy alternatives. In this sense, measurement and indicators are *planning tools.* Third, they help decision-makers decide the degree to which efforts are successful in meeting SD goals and objectives. In this sense, measurement and indicators are *performance assessment tools*.

For all these purposes, decision-makers need tools to connect past and present activities to future goals. Indicators are central among these tools. Yet, there are several limitations of existing approaches. The main difficulties that hinder a more coherent approach to sustainability indicators are the following:

- Lack of consensus on interpretation the role of measurement and indicators
- Difficulties in defining globally accepted indicators
- Different usage of existing indicators
- Limited applicability of existing indicators
- Building on existing but inadequate practice.

Additional work is necessary to address the links between indicators and the political process and to clarify the following questions: Do indicators really influence political decision-making? Under what conditions? Do we really need a single index to help high level decision-makers?

We also need to continue efforts to improve measurement and find answers to the following questions: Which are the main roadblocks in environmental and SD measurements? Can we remove them? Is there a political will to promote the process?

It is paramount to consider the role of transparent and simple methodologies and decide under what conditions the use of simpler methods may be more useful, and whether the use of simple weighted additive indices is better than no weights (i.e. the equal weight of 1) and whether we loose information by aggregation or gain new insights. Simple methods and presentations help interpret the presented indicators and trends. The need for interpretation is also a consequence of the lack of universally accepted indicator sets, and each model has its own definition of several indicators that need explanation. Interpretation also helps the users to understand the context and meaning of the presented indicators.

The final point is that no matter what the selection for framework and methodology is and no matter how technically brilliant and well documented a set of indicators can be, without political will and well-defined objectives of indicators, the measurement will be rather useless for making sustainable development happen.

References

Adriaanse, A., S. Bringezu, A. Hammond, Y. Moriguchi, E. Rodenburg, D. Rogich and H. Schutz. 1997. *Resource Flows: The material basis of industrial economies*. Washington, D.C.: World Resources Institute.

Bakkes, J.A., G.J. van den Born, J.C. Helder, R.J. Swart, C.W. Hope and J.D.E. Parker. 1994. *An Overview of Environmental Indicators: State of the art and perspectives.* Nairobi: Environmental Assessment Sub-Programme, UNEP/RIVM.

Bartelmus, Peter, 1994. *Towards a Framework for Indicators of Sustainable Development*. Department for Economic and Social Information and Policy Analysis (DESIPA) Working Paper Series no. 7. United Nations, New York.

Bell, Simon and Stephen Morse. 1999. *Sustainability Indicators: Measuring the Immeasurable.* London: Earthscan.

Bringezu, S., F. Hinterberger and H. Schütz. 1994. "Integrating sustainability into the system of national accounts: The case of interregional material flows." Paper presented at the international symposium Models of Sustainable Development - Exclusive or Complementary Approaches to Sustainability, Paris.

Cobb C., T. Halstead and J. Rowe. 1995. *The Genuine Progress Indicator. Summary of data and methodology.* San Francisco, California: Redefining Progress.

Consultative Group on SD Indicators. 2000. http://iisd.ca/cgsdi/dashboard.htm and http://esl.jrc.it/envind/idm/

Daly, H.E. and J.B. Cobb Jr. 1994. *For the common good. Redirecting the economy toward community, the environment, and a sustainable future.* Boston, MA: Beacon Press, 1994.

EuroStat 1997. *Environmental Indicators and Green Accounting*. Luxembourg: Eurostat, European Commission.

1999. *Towards Environmental Pressure Indicators for the EU*. Theme 8 Environment and Energy. European Commission and Eurostat 1999, Brussels and Luxembourg

GEO 1997. *Global Environment Outlook.* New York and Oxford: UNEP and Oxford University Press, 1997

GEO 1999. *Global Environment Outlook 2000*. London: UNEP and Earthscan 1999.

Hardi, P. 2001. "Trendsetters, Followers And Skeptics: The State of Sustainable Development Indicators: A Review Essay" , *Journal of Industrial Ecology*, Vol. 4, No. 4, pp. 149-162.

Hardi, P. and T. Zdan (Eds.). 1997. *Assessing Sustainable Development: Principles in Practice*. Winnipeg: IISD.

ISD 2002. International Institute for Sustainable Development, Winnipeg, Manitoba *http://www.iisd.org*

IUCN 1997. International Union for the Conservation of Nature and Natural Resources, and IDRC, International Development and Research Centre (Canada). *An Approachto Assessing Progress toward Sustainability: Tools and Training Series.* Gland, Switzerland: IUCN, IDRC 1997..

Jacobs, M. 1991 and 1993. *The Green Economy: Environment, Sustainable Development, and the Politics of the Future.* London: Pluto Press; Vancouver: UBC Press.

Kunte, A., K. Hamilton, J. Dixon, M. Clemens, 1998. *Estimating National Wealth: Methodology and Results*. Environment Department Papers. Washington, D.C.: The World Bank

NCEDMR 2001. http://www.ncedr.org/tools/tools/info_analysis.htm

Nilsson, J. and S. Bergström. 1995. "Indicators for the assessment of ecological and economic consequences of municipal policies for resource use." *Ecological Economics*, Vol. 14, No. 3, pp. 175-184.

NRTEE. 1995. *Pathways to Sustainability: Assessing Our Progress.* Tony Hodge et al. eds. Ottawa: National Round Table on the Environment and the Economy.

OECD, Organization for Economic Co-operation and Development. 1993. "Environmental indicators: Basic concepts and terminology." Draft Background Paper No. 1, Paris: Group on the State of the Environment, Environment Directorate. Organization for Economic Co-operation and Development.

1998. *Towards Sustainable Development: Environmental Indicators.* Paris: OECD.

1999. "Sustainable development and its economic, social, environmental indicators." Paper presented at OECD Conference Towards Sustainable Development – Indicators to Measure Progress, Rome.

Pearce, D. 1999. "The policy relevance and uses of aggregate indicators: Genuine savings." Paper presented at the Second OECD Expert Workshop Frameworks to Measure Sustainable Development, 2-3 September 1999, Paris.

Rapport, D. and A. Friend. 1979. *Towards a Ccomprehensive Framework for Environmental Statistics: A Stress-response Approach.* Statistics Canada Catalogue 11-510*.* Ottawa: Minister of Supply and Services Canada.

Prescott-Allen, R. 2001. *The Well-Being of Nations.* Gland, Switzerland: International Union for the Conservation of Nature 2001

Rechatin, Cécile, Jacques Theys, Thierry Lavoux and Vincent Piveteau. 1997. *Indicators of Sustainable Development: A Synopsis of Work Abroad and Key Points for Discussion.* Notes de méthode No. 8. Paris: Institut français de l'environnement (IFEN).

Rotmans, J. and B. de Vries (Eds.). 1997. *Perspectives on Global Change. The TARGETS Approach*. Cambridge: Cambridge University Press.

Schmidt-Bleek, F. 1994. *Wieviel Umwelt braucht der Mensch, MIPS Das Maas für ökologisches Wirtschaften.* Berlin: Birkhäuser.

U.S. Interagency Working Group on Sustainable Development Indicators. Dec. 1998. *Sustainable Development in the United States: An Experimental Set of Indicators.* Washington, DC: U.S. Interagency Working Group on Sustainable Development Indicators.

UN CSD, United Nations Commission on Sustainable Development. 1996. *Indicators of Sustainable Development Framework and Methodologies*. New York: UN Commission on Sustainable Development.

UN DESA. 1999. *International Workshop on CSD Indicators of Sustainable*

Development. Meeting Report. Bridgetown, Barbados: 7-9 December, 1999

UN DPCSD, United Nations Department of Policy Co-ordination and Sustainable Development. 1995. "The role of indicators in decision-making." Discussion paper prepared for the International Consultation on Sustainable Development Indicators. Ghent, Belgium: Federal Planning Office of Belgium.

1996. *Integrating Environment and Development in Decision-Making*. Report on Chapter 8 of Agenda 21. New York: UN Department of Policy Co-ordination and Sustainable Development.

Van Dieren, W. (Ed.). 1995. *Taking Nature Into Account.* A Report to the Club of Rome*.*

New York: Springer

Wackernagel, M. and W. Rees. 1996. *Our Ecological Footprint: Reducing Human Impact on the Earth.* Gabriola Island: New Society Publishers.

World Bank 1993. *System of National Accounts.* Brussels/Luxembourg, New York, Paris, Washington, D.C.: The World Bank

1995. *Monitoring Environmental Progress. A Report on Work in Progress.* Washington, D.C.: The World Bank

1996. *Monitoring Environmental Progress. Expanding the Measure of Wealth*. Brussels/Luxembourg, New York, Paris, Washington, D.C.: The World Bank

1997. *Expanding the Measure of Wealth. Indicators of Environmentally Sustainable Development.* Washington, D.C.: The World Bank

WEF (2000): *Environmental Sustainability Index*. World Economic Forum Jan. 2001, Davos, Switzerland

Energy and transport: pricing externalities in the European Union

Domenico Rossetti di Valdalbero[4]
Jane Balen

Directorate General for Research, European Commission (MO75 7/1)
200 Rue de la Loi, B - 1049 Brussels, Belgium
domenico.rossetti-di-valdalbero@cec.eu.int

[4] The views presented in this paper do not necessarily reflect the European Commission official positions and the author alone assume the responsibility for the contents.

Summary

External costs are the costs imposed on society and the environment that are not accounted for by producers and consumers of energy, i.e. that are not included in the market (private) price. They reveal, for example for the electricity production or for transport sector, the fuels and technologies that have the largest impacts (damages) on health and environment.

How to quantify these damages provoked by air pollution? What methodology should be applied? How much does it cost? Is the methodology used in concrete case studies? What conclusions could be drawn? How policy-makers can "internalise external costs"?

Even before the launching of the European Research Area and its part entitled "Developing the research needed for political decision", the European ExternE project co-funded by DG Research had the ambitious goal to provide scientific data on this sensitive issue.

A large European research project

ExternE is an European Union energy socio-economic research project which involved methodological studies, surveys and case studies in order to provide scientific data on "the external costs" of electricity and transport sectors. External costs are the costs imposed on society and the environment that are not accounted for by producers and consumers of energy, i.e. that are not included in the market price.

The questions the project aimed to answer are intended to facilitate the political decision making as regards externalities in energy production. Namely, the principal aspiration was to work out whether it is possible to quantify the damages to human health and environment coming from air pollution? Furthermore, the research would show whether a monetary value could be put on these damages? Subsequently, the project reveals, as regards electricity production and transport, the fuels and technologies that provoke the largest socio-environmental impacts (damages on human health and environment).

ExternE involved an extended European research network comprised of, essentially academics from, all the EU Member States. Namely, VEA in Austria, VITO in Belgium, IER, Universität Stuttgart in Germany, Risoe National Laboratory in Denmark, CIEMAT in Spain, NTUA in Greece, ARMINES in France, EKONO and VTT in Finland, Fondazione ENI and IEFE in Italy, Energy Conversion Centre - University College Dublin in Ireland, IVM, Vrije Universiteit, Amsterdam in The Netherlands, ENCO Environmental Consultants in Norway, CEETA in Portugal, Stockholm Environmental Institute in Sweden, AEA Technology in the UK.

In total, the various ExternE projects have had a time span of over ten years and funding of approximately 10 Million Euros from the European Union. Nowadays, ExternE is one of the most frequently quoted references as regards the issue of external costs.

Under the 5th RTD Framework Programme, the ExternE Research Project was covered under the energy RTD activities of a generic nature in the "socio-economic aspects of energy within the perspective of sustainable development (the impact on society, the economy and employment)". This comprised acceptability and choices, innovation, externalities, economy-environment-energy modelling and matching technology implementation potentials.

The impact pathway methodology

The objective of the ExternE project is to quantify the socio-environmental impacts and costs from the electricity generation and the transport sectors through the "impact pathway analysis" approach (cf. Figure 1). The methodology used is strongly linked to the evaluation of damage to human health, the natural and built environments and to global warming caused by air pollution.

Firstly, the atmospheric dispersion model is used to identify the source of pollution in terms of the site of pollution and the technology responsible and to determine the rate of emission, for example of particulates in kilogramme/year. Thus, it determines the increase in concentration at the receptor sites.

Secondly, the exposure response function is used to determine the impact of the pollution on human health, environment and global warming. It could be the number of illnesses caused by the concentration of particulates.

Finally, the cost of the damage to human health, the environment and the climate is measured through the willingness to pay of the affected individual in order to avoid a negative impact.

This monetary valuation provides, mainly for power generation and the transport sector, a figure corresponding to the so-called "external costs" (in Euro cents per kilowatt-hours for electricity and, for eg., in Euro cents per vehicle – kilometre for transport). This figure has been calculated for case studies around all of the European Union as regards the different fuel cycles (namely fossil fuels, nuclear and renewable technologies) and the different transport technologies. ExternE follows a bottom up approach. The methodology is site-specific and the results then vary according the location: in a urban area, the human health damages from a power plant or a track will be more important than in a rural and less density populated area.

The ExternE results

Compared to an electricity generation cost of about 4 Euro cents per kWh, ExternE shows that to internalise the external costs would significantly increase (almost double) the costs of producing electricity from coal or oil and moderately (by about 30%) increase the costs of producing electricity from gas. Nuclear power has relatively low external costs due to its low influence on global warming and a low probability of accidents in EU power plants. Out of the different technologies, wind and hydro energy present the lowest external costs.

It is worthwhile to mention that the ExternE figures largely vary according to the site of the power plant (higher external costs in urban areas than in rural ones because "receptors" like the population is more important). For most European Union countries, the total damage costs from the electricity sector (excluding global warming) are between 1 and 2% of GDP.

In Table 1 regarding the external costs for electricity production in Germany, the columns present the main categories of external costs coming from different sources: coal, lignite, gas (combined cycle), nuclear, photovoltaic and wind. The horizontal axis indicates the main calculated sub-categories: public health, occupational health, crop losses, material damage and global warming. From this table, it is possible to draw two conclusions:

- coal and lignite have the highest external costs (in comparison to gas, nuclear or renewables);
- The fork for global warming results is very important (a more than 100% variation between the lower and the highest value), i.e. that is the category with the highest uncertainties.

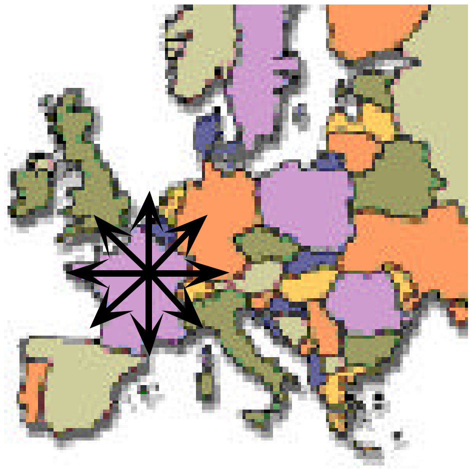
FIGURE 1: IMPACT PATHWAY ANALYSIS

SOURCE
(specification of site and technology)

Þ emission
(e.g., kg/yr of particulates)

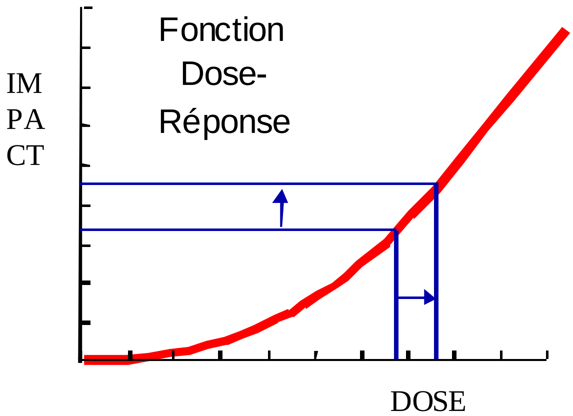
DISPERSION
(e.g. atmospheric dispersion model)

Þ increase in concentration
at receptor sites
(e.g., µg/m^3 of particulates
in all affected regions)



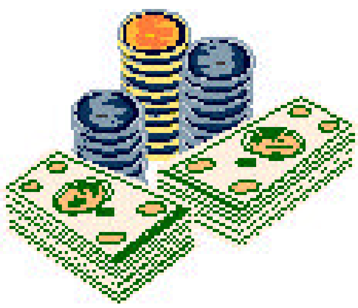
DOSE-RESPONSE FUNCTION
(or exposure-response function)

Þ impact
(e.g., cases of asthma due to ambient concentration of particulates)



MONETARY VALUATION

Þ cost
(e.g., cost of asthma)



Damages are summed over all receptors (all of Europe)

Euro/kWh = **Euro/kg** (unit damage) ´ **kg/kWh** (emission)

Table 1: External costs for electricity production in Germany (in Euro cents/kWh)

	Coal	Lignite	Gas CC	Nuclear	PV	Wind
Public Health	0.9	1	0.3	0.03* - 0.1**	0.4	0.02
Occupational Health	0.1	0	0.002	0.005	0.03	0.004
Crop Losses	- 0.03	-0.03	-0.01	0.004	-0.003	0.0005
Material damage	0.02	0.02	0.004	0.001	0.01	0.0003
Global Warming	1.6 - 4.1	1.9 - 4.9	0.7 - 1.8	0.04 - 0.09	0.1 - 0.3	0.01 - 0.03
SUB-TOTAL	**2.6-5.1**	**2.9-5.9**	**1.0-2.1**	**0.1-0.2**	**0.5-0.7**	**0.035 - 0.061**

Source : IER, 1998 * : 3% discount rate ** : 0% discount rate

From the synthetic Table 2 concerning the European case studies analysed (without Luxembourg but with Norway), some conclusions appear:

- coal and lignite produced electricity provokes about three times more external costs than gas in all the case studies (respectively 2-15 Euro cents/kWh and 1-4 Euro cents/kWh);
- with the same fuel, combined heat and power (CHP) reduces the socio-environmental damages by a factor two;
- nuclear generates quite low external costs (EU nuclear power stations are statistically very safe and there is approximately no influence from the nuclear reactors on global warming);
- renewables, especially wind energy, appear as the energy sources having the lowest external costs.

From the Table 3 concerning the external costs for passenger cars in the European Union, it is worthwhile to mention that (1) the current gasoline costs (without tax) amounts to 0.03 Euro/vehicle.km, (2) the high external cost for diesel in urban surroundings is 70% due to soot and, considering the Life Cycle Analysis, (3) the external costs are essentially due to the vehicle use.

Table 4 highlights the results related to the evaluation of damages from different greenhouse gases (GHG) with two different models (called FUND and Open Framework) and two discount rates (1% and 3%) and considering 2100 as the time horizon of damages. The basis of this scenario has been the IPCC IS92A scenario. It is particularly relevant to make the comparison of the CO_2 marginal damage with a discount rate of 3% (the most often used discount rate by environmental economists) with the cost-effective options to reduce CO_2 (at a cost of less than 20 euros per tonne) identified in the European Climate Change Programme

Table 2: External costs for electricity production in the EU (in Euro cents/kWh**)

Country	Coal & lignite	Peat	Oil	Gas	Nuclear	Biomass	Hydro	PV	Wind	Waste (€/t waste)
AUT				1-3		2-3	0.1			
BE	4-15			1-2	0.5					
DE	3-6		5-8	1-2	0.2	3		0.6	0.05	
	*CHP*** 1-2			*CHP*** 1						
DK	4-7			2-3		1			0.1	
ES	5-8			1-2		3-5***			0.2	15-24
FI	2-4	2-5				1				
FR	7-10		8-11	2-4	0.3	1	1			67-92
GR	5-8		3-5	1		0-0.8	1		0.25	
IE	6-8	3-4								
IT			3-6	2-3			0.3			46-77
				*CHP*** 1-2						
NL	3-4			1-2	0.7	0.5				
NO				1-2		0.2	0.2		0-0.25	
PT	4-7			1-2		1-2	0.03			
SE	2-4					0.3	0-0.7			
UK	4-7		3-5	1-2	0.25	1			0.15	

* Sub-total of quantifiable externalities (such as global warming, public health, occupational health, material damage)
** Combined Heat and Power (allocation of external costs to heat and power)
*** Biomass co-fired with lignites

Table 3: External costs for passenger cars in the EU (in Euro/vehicle.km)
Gross estimates

	Petrol	**Diesel**
Rural	0.01	0.02
Urban	0.05	0.30

Table 4: Marginal Damages (euros) of GHG Emissions

GREENHOUSE GAS	DAMAGE UNIT	MARGINAL DAMAGE FROM MODEL			
		FUND		OPEN FRAMEWORK	
		DISCOUNT RATE: 1%	DISC. RATE: 3%	1%	3%
CARBON DIOXIDE, CO_2	EURO/TC	170	70	160	74
	EURO/TCO_2	46	19	44	20
METHANE, CH_4	EURO/TCH_4	530	350	400	380
NITROUS OXIDE, N_2O	EURO/TN_2O	17 000	6 400	26 000	11 000

External costs policy applications

Different European documents quote or make reference to the "external costs".

The Communication on the Sixth Environment Action Programme[5], the Green paper: towards a European Strategy for the security of energy supply[6], the White Paper on European transport policy for 2010[7] and the Community guidelines on State aid for environmental protection[8].

The Communication on the Sixth Environment Action Programme entitled "Environment 2010: our future, our choice" insists on the fact that *"Protecting the environment... is not only that people aspire to living in a clean and healthy environment but we must also recognise that the costs and other damages caused by pollution and climate change are considerable".* Furthermore, it insists that *"to ensure that those who cause injury to human health or cause damage to the environment are held responsible for their actions".*

The Green paper: towards a European Strategy for the security of energy supply mentions that *"Fiscal instrument (...) should lead to the internalisation of damage caused to the environment".* At the same time, the Directive on the promotion of electricity produced from renewable energy source in the internal electricity market [9] states that there is a "*Need to internalise external costs o electricity generation".*

The White Paper on European transport policy for 2010 maintains that the European Union should be heading *"Towards modal rebalance and greater internalisation of external costs"* which may be achieved by *"Replacing existing transport system taxes with more effective instruments for integrating infrastructure and external costs".*

The Community guidelines on State aid for environmental protection[10] mention that "*the principle of "prices to reflect costs" states that the prices of goods or services should incorporate the external costs associated with the negative impact on the environment of their production*

[5] COM (2001)31
[6] COM (2000)769
[7] COM (2001)370
[8] OJEC, C 37
[9] OJEC, L 283
[10] OJEC, C 37

and marketing (...). Member States may grant operating aid to new plants producing renewable energy that will be calculated on the basis of the external costs avoided (...). At any event, the amount of the aid thus granted to the renewable energy producer must not exceed 5 Euro cents per kWh".

Future research topics

A further improvement of the methodology is currently carried out by the recently launched NEWEXT project (RTD ENERGIE programme). This project lasts for 30 months and involves the following six European research teams: IER, University of Stuttgart in Germany (Co-ordinator), ARMINES and Paris University in France, VITO in Belgium, University of Bath in the UK and PSI in Switzerland. The European Commission financial contribution amounts to more than 500,000 Euros.

- NEWEXT (new elements for the assessment of external costs from energy technologies) covers four main tasks:
- Improvement of the monetary valuation of mortality risks (from value of statistical life to the value of life year lost);
- Inclusion of additional impacts by using the standard price approach for the evaluation of impacts of acidification and eutrophication on ecosystem and biodiversity (valuation of environmental impacts);
- Effects from multi-media (air/water/soil) impact pathways;
- Externalities from major accidents in non-nuclear fuel chains.

The potential future research issues

- To find a comparable basis between electricity and transport sectors external costs;
- To evaluate the external costs electricity fuel cycles in Central and Eastern European Countries;
- To precise the methodology for ecosystem damages (cf. the “environmental liability” discussions in the EU);
- To engage a stakeholder interactive dialogue about ExternE methodology and results;
- To establish the ExternE methodology at the international level;
- To go beyond the “bottom-up approach” and aggregate the results at the EU level;
- To search a way to evaluate the positive external costs of security of supply;
- To continue to support policy-making and to develop a European scientific reference system (cf. the European Research Area[11]) in the field of external costs.

Conclusions

- The external costs figures should not be taken at the comma level but at the “fork level”;
- A “ranking of technologies” according to their socio-environmental damages should be made continuously (progress should be taken into consideration);
- Subsidies or RTD favouring less damaging technologies could also “internalise external costs" (not only taxation);
- Policy makers willing to act for a less damaging world need to have scientific basis to their decisions;
- Results are – and will remain – uncertain (technologies used, location, willingness to pay,…..) but the quantification of external costs has largely reduced the uncertainty for decision-makers.

[11] COM(2000)612

Information

To obtain a copy of the last ExternE publications (methodology, global warming, fuels cycles for emerging and end-use technologies, transport & waste, national implementation):

Email: Domenico.rossetti-di-valdalbero@cec.eu.int

References

Communication on the Sixth Environment Action Programme of the European Community, COM(2001)31.

Community guidelines on State aid for environmental protection, OJEC, C 37.

Green paper: towards a European Strategy for the security of energy supply, COM(2000)769.

Eurelectric, Pricing the environment? An update on ExternE, Proceedings, Brussels, 2001.

ExternE: Externalities of Energy, *Summary*, vol. 1, EC - DG XII, OPEC, Luxembourg, 1995.

ExternE: Externalities of Energy, *Methodology*, vol. 2, EC - DG XII, OPEC, Luxembourg, 1995.

ExternE: Externalities of Energy, *Coal and Lignite*, vol. 3, EC - DG XII, OPEC, Luxembourg, 1995.

ExternE: Externalities of Energy, *Oil and Gas*, vol. 4, EC - DG XII, OPEC, Luxembourg, 1995.

ExternE: Externalities of Energy, *Nuclear*, vol. 5, EC - DG XII, OPEC, Luxembourg, 1995.

ExternE: Externalities of Energy, *Wind and Hydro*, vol. 6, DG XII, OPEC, Luxembourg, 1995.

ExternE: Externalities of Energy, *Methodology 1998 update*, vol. 7, EC, Research DG, Luxembourg, 1999.

ExternE: Externalities of Energy, *Global Warming*, vol. 8, EC - Research DG, Luxembourg, 1999.

ExternE: Externalities of Energy, *Fuel Cycles for Emerging and End-Use Technologies, Transport and Waste*, vol. 9, EC - Research DG, Luxembourg, 1999.

ExternE: Externalities of Energy, *National Implementation*, vol. 10, EC - Research DG, Luxembourg, 1999.

Making a reality of the European Research Area: guidelines for EU research activities (2002-2006), COM(2000)612.

White Paper on European transport policy for 2010, COM(2001)370.

Does measurement count?

Assessing the influence of sustainability indicators in policymaking

Florian Sommer, Senior Researcher

New Economics Foundation - Cinnamon House
6-8 Cole Street,UK – London SE1 4YH
United Kingdom
florian.sommer@neweconomics.org
www.neweconomics.org

Summary

In 1992 the Agenda 21 called for the development of sustainability indicators at all levels – the national, regional, and the local. Indicators would be needed to guide policy makers towards sustainable development. Since then governments and researchers have put a lot of effort into the development of sustainability indicators. Nearly a decade later we can find indicators everywhere. But do they make a difference? How far does the use of indicators support and influence policy making? The Pastille project analysed the use of indicators in London Borough of Southwark, Vienna, Lyon and Winterthur in order to find answers to these questions. This note presents some findings from the Pastille research. It concludes that indicators have only very little influence on policy making. A new approach based on management principles is needed in order to make measurement count in policy making.

Indicators everywhere

It is now ten years since sustainable development was put at the top of the agenda during the Rio Summit in 1992. At the time sustainable development was not well understood by the many governments who had committed themselves to it. There was confusion about the implications of sustainable development and a need for guidance for policymakers. Sustainability indicators were seen as useful tools for guiding policymakers. In the Agenda 21 – the global implementation strategy for sustainable development – it was stressed that:

"Indicators of sustainable development need to be developed at all levels – the international, national, and the local" (Agenda 21, 1992)

As a consequence of this call numerous indicator initiatives spread across Europe. The following section describe briefly the main indicator initiatives in the UK:[12]

- The first national set of sustainability indicators was published by the Department of Environment in 1996. A revised set was launched in 1999 by the Department of Environment, Transport and the Regions (DETR).[13]
- A year later the DETR launched also regional sustainability indicators. Most indicator initiatives have occurred at the local level.[14]
- In 1999, the DETR published a set of local sustainability indicators based on a pilot with 32 local governments. Building on this work the UK Audit Commission has just completed a pilot of a set of local quality of life indicators with over 90 UK local governments.[15]
- In addition to indicator initiatives co-ordinated by central government there have been numerous local governments, which have developed their own sustainability indicators in the context of the Local Agenda 21.[16]

[12] The UK government uses the term 'quality of life indicators' instead of 'sustainability indicators'.

[13] Quality of Life Counts. Indicators for a strategy for sustainable development for the United Kingdom: a baseline assessment, DETR, 1999.

[13]Regional Quality of Life Counts. Regional versions of the national headline indicators of sustainable development, DETR, 2000.

[14]Local Quality of Life Counts. A handbook for a menu of local indicators of sustainable development, DETR, 2000.

[15] For further information see http://www.audit-commission.gov.uk/pis/quality-of-life-indicators.shtml

And finally, there have also been several European local indicator initiatives, such as the EC Urban Audit (58 local governments) and the European Common Indicators (over 100 local governments). The set of the European Common Indicators is shown below:

To conclude, it is fair to say that the call of the Agenda 21 has been taken seriously – certainly amongst local governments. In the UK at least 100 local governments are now using local sustainability indicators.

European Common Indicators (ECI) for Local Sustainability launched in February 2000	
Issue:	**Indicator:**
1. Citizen satisfaction with the local community:	*Citizens' general satisfaction with various features in the municipality*
2. Local contribution to global climatic change:	*CO_2-emissions (in the longer term, when simplified methodology has been identified, this indicator will focus on the ecological footprint)*
3. Local mobility and passenger transportation:	*Daily passenger transportation distances and modes of transportation*
4. Availability of local public green areas and local services:	*Citizen access to nearby public green areas and basic services*
5. Quality of local outdoor air	*Number of days with good and healthy air quality*
6. Children's journeys to and from school	*Mode of transportation used by children to travel between home and school*
7. Sustainable management of the local authority and local businesses	*Share of public and private organisations adopting and using environmental and social management procedures*
8. Noise pollution	*Share of population exposed to harmful environmental noise*
9. Sustainable land use	*Sustainable development, restoration and protection of land and sites in the municipality*
10. Products promoting sustainability	*Share of eco-labelled, organic or fair-trade products of total consumption*

Do indicators make a difference?

Indicators are now widely used in local governments across local governments in Europe. But to what extent do they actually make a difference in policy-making? This question has been central to the Pastille project (see below).

PASTILLE Promoting Action for Sustainability Through Indicators at the Local Level in Europe

The Pastille research Project, funded under the 5th framework of the European Union, is being undertaken by a consortium from Vienna (Austria), Lyon (France), Winterthur (Switzerland), and London (UK). Each country team is a partnership between a local government and a research Institute. The consortium is co-ordinated by the London School of Economics.

Pastille runs from March 2000 until September 2002. The key aims of Pastille are:

- To define the range of roles that local sustainability indicators can play.
- To examine how sustainability indicators are developed and used in each of the four cities
- To assess the impact and effectiveness of sustainability indicators.

Contact information: pastille@lse.ac.uk / http://www.lse.ac.uk/Depts/geography/Pastille

Pastille has analysed the use of indicators sets in four European cities over a period of eighteen months. The overriding conclusion is that indicators do not have a significant influence on decision-making processes in local governments. The New Economics Foundation came to a similar conclusion when it recently interviewed a range of different UK indicator experts. As one person put it:

"Indicators are fun but they do not influence policy making"

The Pastille project identified a number of barriers, which prevented that indicators are influential in policymaking processes:

- Key stakeholders, such as senior policy officers, have not bought into the use of sustainability indicators. Indicators are tolerated but not used as guiding policy tools.
- Sustainability indicators are voluntary based initiatives. There is little formal authority behind sustainability indicators and therefore little incentives to pay attention to indicator findings.
- Sustainability indicators do not fit into the culture of local governments. Established routines make it difficult for indicators to gain recognition.
- Sustainability indicators are usually led by one department, e.g. environment. Existing conflicts with other departments prevent joined up action across the local government.
- The findings of indicators are poorly communicated.
- There is often a lack of trust in indicators and those who are managing them.
- The findings of indicators do not count very much when compared with financial or political considerations.

A new focus on management of indicators

If indicators have no influence on policy-making, why bother using them? Development and use of indicators cost money and can frustrate people who put a lot of effort into it. Why not dump indicators and concentrate resources on real action projects?

My view is that despite these problems there is future role for sustainability indicators. First of all indicators are not only about guiding decision makers. Indicators serve other purposes such as raising awareness about sustainability, creating a platform for debate, and encourage learning between different stakeholder groups. The research of Pastille shows that indicators have been more successful in fulfilling these purposes.

Secondly, it is possible to overcome some of the barriers, which have been identified by Pastille. Most of the barriers are related to the management of indicators. The understanding about the management of indicators is just starting to emerge. Below are some recommendations which have been identified by Pastille:

- All key stakeholders need to buy into the indicator process. There needs to be a shared a vision about indicator development and use.
- The indicators process needs to be led by someone who is credible and can be trusted by key stakeholders.
- Indicators need to be integrated into formal procedures or linked to agreed thresholds.
- The findings of indicators need to be timely and effectively communicated to all relevant stakeholders.

To date most of the efforts are still concentrated on developing the "right" set of sustainability indicators. The research by Pastille has shown that in terms of influencing policymaking the management of indicators is more important than the indicators themselves.

"Making Indicators Count" project

The New Economics Foundation is currently exploring the issue of managing local sustainability indicators. "Making Indicators Count"[17] is a project of the New Economics Foundation and the University of the West of England, which explores how to make measurement more influential in local governance. Between March 2002 and February 2003 "Making Indicators Count" will work with 90 UK local governments, which are experienced in indicator use. In short, "Making Indicators Count" will:

1. Identify to what extent and in what ways measurement influences decision-making and positive action towards sustainability;
2. Increase understanding of why indicators are influential in some contexts and not in others;
3. Identify a set of guiding principles for making measurement more influential in local governance;
4. Publish a policy report and toolkit for practitioners.

[16] For further information on 'Making Indicators Count' please contact Florian Sommer, New Economics Foundation

The CLIMNEG Research Network

Johan Eyckmans

Postdoctoral fellow of the Fund for Scientific Research –
Flanders (Belgium) F.W.O.

Katholieke Universiteit Leuven
Centrum voor Economische Studiën
Naamsestraat 69 B-3000 Leuven (Belgium)
johan.eyckmans@econ.kuleuven.ac.be

Short description of the CLIMNEG research network

The CLIMNEG (=CLIMate NEGotiations) project is an interdisciplinary study of decision making in matters relating to climate change[18]. The overall objective is to integrate the insights that can be obtained from economic theory, climate sciences, economic simulations, administrative and diplomatic experience in the area of climate change policy, using simulation models as main research tool and common language. The project was funded under the first scientific support plan for a sustainable development policy[19] of the Belgian Federal Office for Scientific, Technical and Cultural Affairs[20] (OSTC) under the subprogramme Global Change and Sustainable Development. It started in 1996 and ended in 2001. Recently, a follow up programme, CLIMNEG 2, has been approved under the second scientific support plan for a sustainable development policy of the Belgian Federal Office for Scientific, Technical and Cultural Affairs (OSTC). CLIMNEG 2 started in January 2002 and continues until 2005. In this contribution, I will however focus mainly on the first CLIMNEG project.

The CLIMNEG network brings together three university research departments: (1) Université catholique de Louvain, Center for Operations Research and Econometrics (UcL-CORE), (2) Université catholique de Louvain, Institut d'Astronomie et de Geophysique George Lemaitre (UcL-ASTR) and (3) Katholieke Universiteit Leuven, Centrum voor Economische Studiën, working group Energy, Transport and Environment (K.U.Leuven-CES-ETE). In addition the CLIMNEG project involves a federal administration, the Belgian Federal Planning Bureau (FPB).

The CLIMNEG research project consists of four different subprojects:

Project CLIMNEG I: ECONOMIC THEORY (UcL-CORE) - Prof. Henry Tulkens and Prof. Claude d'Aspremont
On the basis of an economico-climatic model, the three purposes of this subproject are (*i*) to characterise policies of greenhouse gases abatement within the world, Europe and Belgium in terms of four alternative criteria: economic optimality, ecological sustainability, equity and strategic stability, (*ii*) to analyse different ways to share the burden of those policies, and (*iii*) to examine the possibility of activities to be implemented jointly by different groups of countries, in particular by means of the flexible mechanisms provided for in the Kyoto Protocol.

Project CLIMNEG II: CLIMATE SCIENCE (UcL-ASTR) - Prof. Jean-Pascal van Ypersele
The CLIMNEG II projects aims at enriching the climatic component of the basic economico-climatic model by integrating transfer functions that reflect the most recent state of the art, for evaluating the effects on the global and regional climate of the different emission scenarios studied in the economic component. Particular attention is given to sulphate aerosols, which tend to compensate partially the warming due to greenhouse gases. The interdisciplinary transfer of the latest climate research results for economic studies is an integral part of this subproject.

Project CLIMNEG III: ECONOMIC SIMULATIONS (K.U.Leuven-CES-ETE) - Prof. Stef Proost
The purpose of subprogramme CLIMNEG III is to simulate numerically the effects of the greenhouse gas emission reduction policies identified by the CLIMNEG I team on the national and international economic equilibria. The linking of a climate module to an economic model requires close cooperation with the climatologists of subproject CLIMNEG II.

Project CLIMNEG IV: NEGOTIATIONS (Belgian Federal Planning Bureau) - Mrs. Nadine Gouzée

[18] More information, including the final reports, can be found at projects website http://www.core.ucl.ac.be/climneg/ or through the FEDRA database of OSTC:
http://www.belspo.be/belspo/ostc/act_scien/fedra/proj.asp?l=uk&COD=CG/DD1/241.
[19] For more information on this research programme, see
http://www.belspo.be/belspo/ostc/geninfo/org/progrli_uk.stm.
[20] More information on the OSTC can be found at http://www.belspo.be.

Finally, the CLIMNEG projects aims at confronting its research activities with practice, by studying two fundamental aspects of the institutional implementation of the policies, namely the international co-ordination in the implementation of the instruments, and the mechanisms of decision making within the concerned countries. For both aspects, the Belgian Federal Planning Bureau is involved in the ongoing policy process on the national and international level.

An overview of the main results of the CLIMNEG project

Although the results are presented below under the headings of the four subprojects outlined above, it must be stressed that the interactions between the researchers have been so strong that all results must be considered common to the entire research group. A companion research project called CLIMBEL, started in 1998, on which it is reported separately, produced further joint results. The working papers of both CLIMNEG and CLIMBEL are collected together in the series *CLIMNEG-CLIMBEL Working Papers* whose titles can be found (and downloaded in most cases) at the CLIMNEG website: http://www.core.ucl.ac.be/climneg. The working papers are referred to by the acronym CWP followed by the number in the series. The complete list of working papers is attached in appendix.

Space constraints for this contribution compels one to make a selection among the contributions made, a selection guided more by the necessity of homogeneity than by the intrinsic importance of some of the papers. The summary is therefore quite incomplete. A fuller appreciation of the contributions can be obtained by reading the final report or, better, the papers themselves.

At the economic theoretical level, the project has yielded the main following insights:

- Extending to *stock* externalities — an extension required by the nature of the climatic change problem — results that were available in the literature *on the strategic stability of cooperative agreements* in transfrontier (flow) pollution problems. The essence of the result obtained here (CWP n° 1, 2, 6) consists of an explicit formula to compute international resource transfers that induce the strategic stability property. The fact that this extension was successful opened the way to the numerical simulations reported below.
- Combining *equity considerations* with efficiency and strategic acceptability conditions in the design of abatement scenarios. The tool is again the one of international resource transfers, inspired by those reported on above, but corrected for equity purposes, and derived from alternative initial allocations of tradable emission permits. (CWP n° 39)
- An economic and game theoretic *interpretation of the Kyoto Protocol* (CWP n° 12). Based upon explicit modelling derived from the economic theory of competitive markets as well as from the theory of cooperative games the three following conclusions are established:
  - the quotas adopted in the Kyoto protocol are a step in the right direction, as far as overall international economic and environmental optimality is concerned;
  - trading mechanisms for emission permits allow for an efficient and strategically stable allocation across countries of the overall abatement effort just mentioned;
  - as far as future commitment periods are concerned, the "Kyoto scheme" of quotas — properly assigned — together with tradable permits constitutes an appropriate instrument for eventually reaching an international optimum, characterised by strategic stability.

At the climate modelling level, the project's main results are as follows:

- An improved climate module has been developed, from a starting model by Kverndokk and Fankhauser (1996), and validated on the basis of other two-dimensional models (CWP n°21).

- Extension of this improved model, whereby emission trajectories are translated into *regional* temperature changes, aimed at being fed back into the economic model through climate change damage functions.
- Introduction of *sulphate aerosols*: sulphate aerosols represent one of the main reasons for which regionalisation of impacts is important in economic studies. A simplified way to represent the regional effect of aerosols was needed, however. A first attempt was made using results from the UcL-ASTR two-dimensional model, which includes the effect of aerosols (CWP n°7). Additional geographical information came from existing three-dimensional simulations made with coupled atmosphere-ocean general circulation models forced with both greenhouse gases and aerosols.

These improvements to the climate module (regionalisation and treatment of sulphate aerosols) allow the coupled climate-economy models mentioned above to be one step ahead of the models existing in the literature. The first simulations using this improved climate module are described in CWP n°32 and in CWP n°44.

As far as economic modelling and econometric simulations are concerned, the project's main results are the following:

- at the *world* level:
  - A six regions integrated assessment model called *"Climneg World Simulation" (CWS)* has been constructed, derived from the Nordhaus and Yang model published in 1996. For this CWS model, the stability inducing transfers identified above have been computed and efficient stable cooperative emission trajectories determined. These appear to be quite more demanding than Nash equilibrium ones, although the economic gain they induce is only moderate. This sheds some light on the issue of the relative importance of national *vs.* global policies. Another remarkable finding from these simulations is that while world consumption is steadily increasing in the long run under the efficient (and stable) emissions scenarios, world consumption is not sustainable under Nash as well as business as usual scenarios in the sense that it is bound to decrease from the middle of the next century on (CWP n° 18 and 19).
  - An extension of the CWS model has been subsequently formulated (CWP n° 32) to account for *sulphate aerosols*, which dampen the effects of CO_2 concentrations on temperature. While this appears to be indeed the case in the early periods, later periods (beyond 2100) exhibit an overwhelming domination of the CO_2 effects, rendering irrational sulphur emissions reduction.
  - Finally, the *stability* of alternative forms of *international cooperation* has been tested using the CWS model in CWP n° 40, based on the theory of endogenous formation of coalitions. The analysis concludes with a strong stability of the "Kyoto coalition", in spite of credible possible deviations on the part of the countries that formerly belonged to the Soviet Union
- at the *European* level:
  - the EU "bubble" burden sharing agreement on the distribution of the Kyoto emission reduction target over the EU member states was investigated using an "inverse optimum" approach and marginal abatement cost curves. The simulations reveal that the EU bubble improves in terms of cost efficiency upon a uniform reduction assignment, but that substantial differences in marginal costs persist. (CWP n°33).
  - using the (pre-existing) GEM-E3-Europe medium term general equilibrium model, marginal abatement cost functions have been estimated for the European countries as well as for 6 to 8 other regions of the world. This was done in order to compare the global costs of emissions reduction under alternative settings, an efficient one and a

uniform one across countries. For the EU countries, the difference shows as follows: for a same tax of $100/ton of CO_2, efficient allocation of the effort reaches 31% whereas uniformity of effort (that is, if no account is taken of cost differences between countries) allows only for 17%.

- Finally, at the *Belgian* level:
  - using the (pre-existing) MARKAL partial equilibrium model of the energy system in Belgium, *marginal abatement costs* of greenhouse gases emissions abatement in 2010 for the country have been estimated. A figure of about BEF 2000 per ton of CO_2 is obtained for reductions corresponding to Belgium's commitment under the Kyoto Protocol (CWP n° 41).
  - *Macroeconomic impacts for Belgium* of alternative domestic policies to meet the Kyoto targets are also reported on in CWP n° 41.

At the interface between research and policy design, an essential part of the CLIMNEG project (one fourth of the resources were devoted to it) was the inclusion in the researchers' team of members of the federal administration of the Belgian government, who are involved in the preparation, the attendance and the follow up of the international climate negotiations.

- The specific tasks assigned to these persons and their activities in the network resulted in four categories of contributions:
- The preparation of *pedagogical documents* destined to political decision makers and high administration officials not directly involved as well as to the public at large, on various aspects of climate change issues, namely: the history and evaluation of international collaboration on climate change over the last ten years (CWP n°28); the theory and evaluation of tradable emission permits (CWP n°29); the fiscal instruments of climate policies (CWP n°30); the regulatory instruments of climate policies (CWP n°31); the communication instruments in national and international climate policies (CWP n°38); the voluntary agreements on emission abatement (types, characteristics, implementation, examples) (CWP n°37). All six documents have been re-issued in French as CWP n°47**.**
- Through the CLIMNEG coordination meetings, continuous *exchanges of information* and ideas between academics and practitioners, which led the former to be regularly briefed by the latter on the most recent developments (*e.g.* after the Kyoto, Berlin, Buenos Ayres, The Hague Conferences of the Parties and other meetings in Bonn). Reciprocally, practitioners have been offered ample exposure to conceptual and methodological results as they were developing, both in climate science and in economics (*e.g.* on alternative climatic models, on tradable permits, on cooperation issues, on simulation techniques, etc.)
- Increased motivation for academic members of the network to take part, when invited to, in several of the key events that occurred over the years in climatic change affairs, both internationally and in Belgian circles.
- Finally, diffusion of knowledge for the public at large, through public seminars, lectures, publishing of vulgarisation articles, and interviews given to the printed and audio-visual press.

Research tools and strategy in the CLIMNEG project

Research tools

Two main research tools were used in the CLIMNEG project:

- Integrated assessment analysis of climate change, i.e. analysis that combines standard economic models of the interaction of consumers, producers, governments through markets, with a stylised representation of the physical environment (carbon cycle and temperature change) in which these interaction take place. Integrated assessment analysis considers full feedback of climate change damages into the economic model. By now, integrated assessment is the standard approach for studying the economics of climate change, see for example Nordhaus (1993), Alcamo (1994), Dowlatabadi 1995), Jansen (1998) or Kolstad and Toman (2000). A survey can be found in Weyant et al. (1996). The CWS model developed under the CLIMNEG project is based upon and closely related to the seminal model RICE, described in Nordhaus and Yang (1996), the FUND model by Toll (1997) or the MERGE model by Manne, Mendelsohn and Richels (1995).

- Mathematical simulation models as common research language. Already in the first contacts between the network members, it became clear that the university teams are all familiar to work with stylised mathematical representations of complex systems (the economy or the climate and carbon cycle). This fact was exploited by the research proposal as it was believed to make mutual understanding and interdisciplinary research easier.

Research strategy

Concerning the research strategy of the network, the following strategic choices were made at the outset of the project:

- It was the intention to bring together a small group of people that are experts in their discipline and that use a similar research methodology (i.e. mathematical modelling, see above) rather than starting an extended network. By doing so, some interesting issues could not be addressed fully (for instance the philosophical questions relating to intergenerational equity or the role of stakeholder participation in the design of climate change policy). But in turn, the interdisciplinary cooperation was intense and deep. In the follow up project of CLIMNEG 2, some of these additional questions will be taken up (see later).
- The CLIMNEG project started with a clearly delineated research agenda. This agenda was however continuously updated in function of the rapid developments in the international and national climate debate. Recall that the CLIMNEG project proposal was written two years before the Kyoto Protocol was negotiated in 1997. Therefore, the international burden sharing for the first commitment period was no longer a research priority in the second half of the CLIMNEG project. On the other hand, much more attention was devoted to the flexible mechanisms (joint implementation, clean development mechanism and emissions trading) that are provided for in the 1997 Kyoto Protocol.
- The CLIMNEG project opted for a in depth analysis instead of a very broad scope. It was an explicit intention to do up-to-date scientific research meeting international standards. This concern is reflected in the fact that the results of the analysis were presented at many national and international scientific conferences and were published in leading field journals.
- An important goal of the CLIMNEG project was also to promote capacity building in Belgium in the area of the economics and policy of climate change.
- Finally, the project intended explicitly to confront its theoretical results with real world climate change policy. This policy relevance is reflected clearly by the participation of Belgian Federal Planning Bureau.

Sustainable development in the CLIMNEG project

How did the CLIMNEG project meet, or fail to meet, the five main characteristics of the concept of Sustainable Development as they are defined in the 1992 Rio Declaration?

Planetary dimension

Three levels of modelisation were considered in the CLIMNEG project:

- the world level (integrated assessment CLIMNEG World Simulation CWS model)
- the European level (general equilibrium model GEM-E3 Europe)
- the Belgian level (partial equilibrium energy model MARKAL)

One of the major preoccupations of the project was to impose consistency of scenarios between the different level. In particular this requires to identify global emission reduction objectives in a first step and to distribute the corresponding emission abatement effort over the different regions in a second step while taking into account arguments of economic efficiency and equity.

Long term perspective

Two time scales were considered in the CLIMNEG project:

- Several centuries for integrated assessment modelling
- Several decades for policy analysis for EU and Belgian level

Interdisciplinary

Several scientific disciplines contributed to the CLIMNEG research:

- *Economic theory* (game theory, welfare economics)
- *Economic modelling* (general equilibrium modelling, dynamic programming, data collection)
- *Climatology* (carbon cycle model, regional temperature change module, interaction global-local pollution for sulphate aerosols)
- *Policy maker* (Belgian Federal Planning Bureau who are actively involved in the Belgian climate negotiation team)

Uncertainty and precautionary principle

Although explicitly mentioned in the original research proposal, uncertainty has been dealt with to a lesser extent in the CLIMNEG project. Basically, this was due to lack of time because the simulation work was requiring a major part of the project's resources. It is however obvious that uncertainty is posing major problems if one wants to define a consistent climate policy.*Therefore, this issue will be taken up in the subsequent CLIMNEG 2 project.*

Participation of stakeholders

Stakeholder participation has been present in the CLIMNEG project to some extent through the collaboration of the Belgian Federal Planning. In particular, the Task Force Sustainable Development of the Federal Planning Bureau develop some didactical tools that are intended to inform the politicians and the general public on climate change.

An illustration of the research methodology and tools: integrated assessment of greenhousegas emission reduction targets at the World, European and Belgian level

World level: CWS model

Following the CLIMNEG research proposal, a literature survey of Integrated Assessment models (available at that time, i.e. 1997-1998) was made. Given the need for simulating game theoretic solutions (Nash and cooperative equilibria) for testing the strategic stability of different CO_2 emission reduction policies, we have chosen to use a relatively simple economic model based on the RICE model by Nordhaus and Yang (1996). This choice was made because calculating non-cooperative solutions requires the use of time consuming numerical approximation algorithms.

The 6-region world simulation model (in the sequel referred to as CWS model, CLIMNEG World Simulations model) developed jointly by the CLIMNEG I, II and III teams is a genuine integrated assessment, economic-climate model. The economic part consists of a dynamic, perfect foresight Ramsey type growth model with endogenous investment, GHG emission reduction choice and damage from climate change. The explicit modelling of the climate feedback mechanism distinguishes Integrated Assessment models from standard economic simulation models.

Basic parameters for emissions, GDP, population, technological change, cost of emission reduction and damage from temperature change were taken from Nordhaus and Yang (1996) and were somewhat adapted to our needs. The most important adaptations concern the absence of world trade, the adoption of a lower discount rate, the upward revision of the exponent of the climate change damage function and the downward revision of the growth rate of the former Soviet Union. A detailed description of the model parameters and the differences with Nordhaus' RICE model can be found in Eyckmans and Tulkens (CWP 18). Different version of the CWS world model are now available under the GAMS numerical optimisation software[21].

The CWS model is flexible in the sense that different carbon cycle/climate modules can be attached to the economic model in order to translate the endogenous emission trajectories in atmospheric carbon concentration and into temperature change. We started with the carbon cycle/climate module by Nordhaus and Yang (1996) but soon the partners of CLIMNEG II made clear that this is a too crude representation of the complex physical atmospheric and climatic phenomena driving climate change. Therefore, CLIMNEG II developed an alternative carbon cycle model (a pulse-response model) which performs better than the original module up to a doubling of the atmospheric carbon concentration. CLIMNEG II also developed a regionalised temperature change module for translating a global temperature variation into regionally differentiated temperature changes. This part is novel in the Integrated Assessment literature, there are only very few IA models with a regionalised climate module.

Moreover, the climate module takes also into account emissions of sulphur particulate matter. Currently, there exists a version of the CWS Model with endogenous choice of not only CO_2 but also sulphur emission trajectories. This model takes into account the effect of sulphur emissions on the global climate change problem (sulphur particles have a regional cooling effect) and on the local acidification problem. Additional cost of sulphur emission reduction and external damage estimates for sulphur emissions have been included in the CWS model, see Eyckmans and Bertrand (CWP 32). The combination and interplay of both local and global pollution problems that are driven by correlated emission processes is currently a hot topic in the environmental economics literature.

We now present some key features of a standard simulation run with the CWS model. The following figures show emission, carbon concentration, temperature change and consumption time path under three scenario's: BAU (Business-As-Usual: no GHG emission reduction policy), KYOTO (only the subgroup of Kyoto countries undertakes emission reductions in order to maximise its group lifetime consumption possibilities) and EFF (EFFiciency: every country undertakes emission reductions in order to maximise total world lifetime consumption possibilities).

[21] GAMS (General Algebraic Modelling System) is a widely used nonlinear optimization software for economic equilibrium models. For more information see http://www.gams.com.

Figure 1: World carbon emissions (gtC)

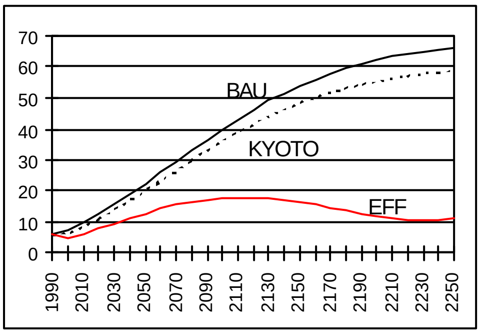


Figure 2: Atmospheric carbon concentrations (gtC)

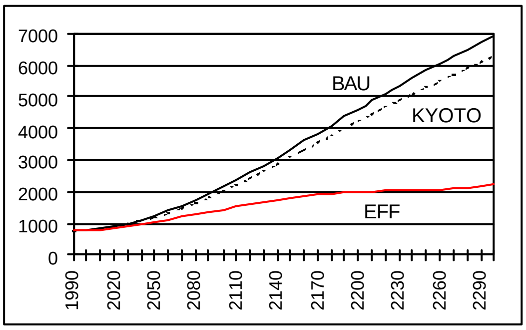


Figure 1 shows the carbon emission trajectories and Figure 2 the corresponding global carbon concentration paths under the three different scenario's. The simulations clearly show the unsustainable nature of both the BAU and the KYOTO scenario because emissions and carbon concentration continue rising unchecked. Only the EFF scenario leads to an approximate stabilisation of GHG concentrations (at 2000 gtC) but requires a huge emission reduction effort.

Figure 3: Temperature change EFF scenario (degrees Celsius)

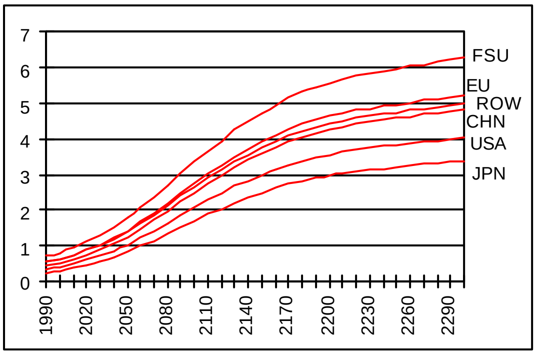


Figure 4: World consumption (1990 = 1)

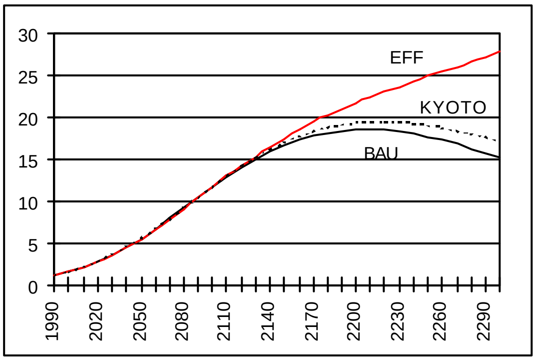


Figure 3 shows the regional temperature change patterns for the EFF scenario. Typically, the Former Soviet Union and EU experience higher temperature change than the USA and Japan. Overall, temperature continues rising in the EFF scenario in spite of the stabilisation of GHG concentrations. It would take even longer (several centuries) before the stabilisation of carbon concentration leads to a stabilisation of temperature because of the inertia and time lags in the climate system.

Finally, Figure 4 shows consumption patterns for the three different scenarios. Again, the unsustainable nature of the BAU and KYOTO scenarios is striking. From 2200 onwards, consumption possibilities would fall as a result of the ever increasing damage from climate change. Only the EFF scenario can prevent this drop in consumption in the long run.

The results of the analysis with the CWS model including climate change and acidification show that the local acidification problem it the main reason for relatively high sulphur emission reduction policies during the following decades. However, from 2100 onwards, the climate change problem become so severe that high sulphur emission reduction is not rational anymore. The results of this analysis are written down in Eyckmans and Bertrand (CWP 32).

Finally, the CLIMNEG III team contributed also to the study of the stability of cooperation by investigating the strategic stability of the Kyoto coalition by means of the CWS model. This analysis is more descriptive instead of normative, it takes the composition of the Kyoto coalition as given and examines whether some of its members are subject to free rider incentives. The analysis made use of recent game theoretic insights (theory of endogenous coalition formation). The main results (see Eyckmans, CWP 40) are:

- the Kyoto coalition is internally highly unstable (according to the cartel stability concept of d'Aspremont et al. 1983) since USA, Japan and Former Soviet Union can improve themselves individually by leaving.
- However, individual deviations are often incredible since they trigger off further subdeviations by other players. Using a more "farsighted" coalition stability concept, see Chwe (1993), it was shown that only the FSU can credible threaten to deviate from the Kyoto coalition.
- Given the previous observation, we believe that the "hot air" that was assigned to the former Soviet Union should be interpreted as a sidepayment in order to convince them to stay within the Protocol and to stabilise cooperation.

World and European level: GEM-E3 model

GEM-E3 is a general equilibrium simulation model that focuses on the medium term. It is specially designed to evaluate the impact of different policies at European or at World level on the welfare of the individual European member states. Its construction was started under an EU Joule Research Project by different European universities. The GEM European version covers each EU country separately, whereas the GEM World version covers 6 to 18 World regions (flexible aggregation). Within this project, the World version of GEM-E3 has been further developed and a baseline scenario has been constructed to be used in the different studies using this model.

The GEM-E3 World model has been used to estimate marginal carbon emission abatement cost (MAC) functions for different world regions under different hypothesis concerning the internal distribution of the abatement target over the emission sectors within countries. This analysis revealed that the way carbon emission control policies are implemented domestically, influences drastically overall abatement costs. The abatement efforts assumed by other countries do not seem to change the national MAC functions. These simulation experiments are not fully completed and have not been written in a working paper yet. The following figures show two sets of MAC functions. In Figure 5 we assume that abatement efforts are allocated efficiently over sectors within each country, i.e. MACs are equalised over the sectors within each region. In Figure 6, it is assumed that MACs are only partially equalised between four sector groups. For instance for the EU, a carbon tax of 100US$/ton CO_2 would achieve 31% emission reduction when efforts are allocated efficiently across sectors against only 17% if they are allocated uniformly without taking into account cost differences between sectors.

Figure 5: efficient national allocation

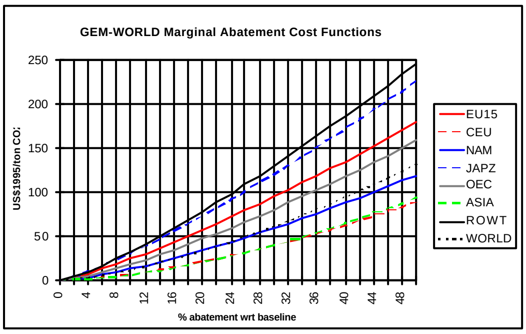
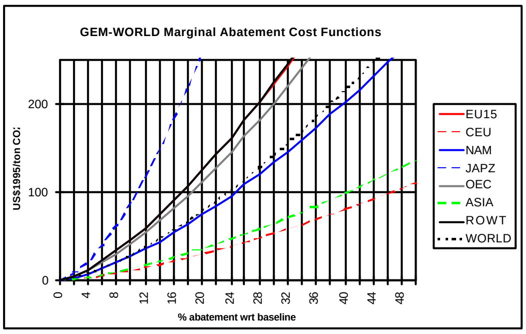


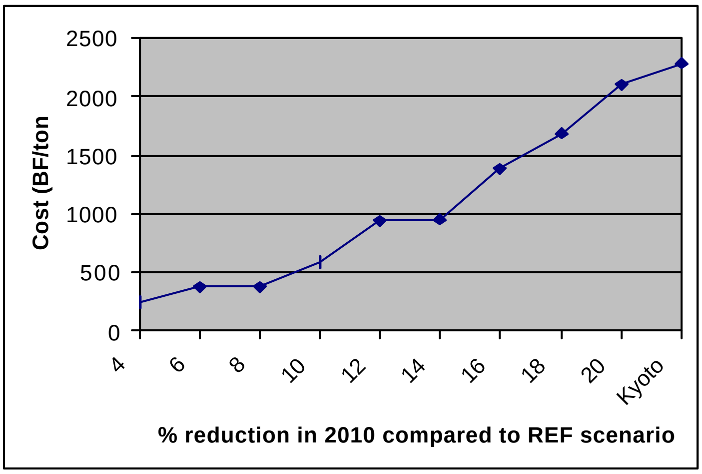
Figure 6: inefficient national allocation



Belgian level

The Markal model, a partial equilibrium model of the energy-system for Belgium, was used to compute a marginal abatement cost function for GHG emission reduction in Belgium in 2010. The model has been implemented for Belgium in a joint research project by CES and VITO under the same Global Change Programmefinanced by OSTC (DWTC/SSTC). The cost function computed with Markal includes the three ways to reduce GHG emissions, i.e. switch to less GHG intensive fuels, the use of more efficient technologies and a reduction the demand for energy services, are included in the cost curve. Until the level of reduction needed to reach the Kyoto target, all sectors make use of these different techniques to reduce GHG emissions, except the transport sector, where the reduction in demand is the only cost-efficient measure. Renewables do not increase their share with the reductions considered in this study. The figure below gives the marginal cost curve for 2010. It shows for different percentage emission GHG reductions in 2010 (from 4% to 20%), the marginal cost of the last ton of GHG emission reduction.

Figure 7: Marginal Cost of GHG emission reduction in Belgium in 2010



The results of this study are described in Proost and Van Regemorter (CWP 41) and were used as basic input for the project of national climate plan published by the Cabinet of the Secretary of State for Energy and Sustainable Development in December 2000.

The GEM European model has been used to evaluate the macroeconomic impact of different policies to reach the Kyoto target for Belgium. This study, done within the framework of CLIMNEG and CLIMBEL projects, is summarised in the CLIMBEL final report and are reported in Proost and Van Regemorter (CWP 41). It was jointly financed by the Belgian Federal Ministry of the Environment.

Difficulties encountered in CLIMNEG

Research projects do not always evolve as smoothly as the participants had intended to at the outset. Sometimes, unforeseen problems arise which hamper the subsequent phases in the project. In the CLIMNEG project, the main difficulties were the following ones:

Incompatible time horizons

In climatology, it is common to use a time horizon of several centuries. In economics however, a time horizon of more than a century is considered as eternity. It is not that economists are "short sighted", it is just a problem of predicting the exponential evolution of technological change. This becomes clear if we make a little thought experiment and place ourselves back to the year 1900 and try to imagine what the world would look like in the year 2001. The 2001 world was literally inconceivable in 1900!

The incompatible time horizons cause a major problem for the simulation model since the global warming induced by the growing greenhouse gas emissions over the 21st century will become visible only in the 22nd century and beyond. Therefore some approximations of the long-term effects of climate change have to be used in the integrated-assessment model.

Incompatible numerical simulation methodologies

Economists typically try to identify optimal policies maximising some measure of benefits minus costs in small scale models of consumer and producer behaviour. Climatologists on the other hand are often simulating huge dynamic systems. This basic difference in methodology caused trouble in the CLIMNEG project since it makes it practically impossible to link an economic model to a state-of-the-art model of the climate system and carbon cycle. There are several ways to circumvent this problem.

First, one can construct so-called "soft" links between the models. For instance, in a first step, the climatologists identify greenhouse gas emission trajectories that lead to stabilisation of the atmospheric concentration of these gases. In a subsequent step, economists identify least-cost options to reach these emission trajectories.

A second solution consists of linking an economic model to a reduced form model of the large scale general circulation models used by the climatologists. This is basically the approached followed in the CWS model. The CLIMNEG II team constructed a new carbon cycle and regionalized temperature module which was linked to the economic module of the RICE model.

Organisational difficulties

At the end of the CLIMNEG project, there was a gap of more than 6 months before the subsequent CLIMNEG 2 project starts. This caused some difficulties in personnel, in particular some senior scientists have left the university research groups.

Future developments

In April 2001, a follow-up research project, called CLIMNEG 2, has been submitted for funding under the second scientific support plan for a sustainable development policy of the Belgian Federal Office for Scientific, Technical and Cultural Affairs (OSTC). It has been approved and will start in January 2002. The new research project is devoted to the analysis of international and Belgian climate change policy questions in the post-Kyoto era. The network intends to be an attraction pole for Belgian academic research concerning the economics of climate change with important interdisciplinary contributions by climatology, agricultural sciences and philosophy. The CLIMNEG 2 project builds further on the basis laid by the CLIMNEG/CLIMBEL research networks sponsored by OSTC under the first scientific support plan for a sustainable development policy.

CLIMNEG 2 is an exercise in *integrated assessment* analysis, i.e. it looks at the problem of climate change from a broad perspective in order to fully appreciate the numerous and complex interactions between the many economic actors (consumers, producers, national governments, supranational organisations) and the complex physical environment they are operating in. This broad perspective is reflected in the extensive geographical coverage (international, European and Belgian perspective), the extensive time horizons considered (several centuries for integrated assessment modelling, several decades for analysis of EU and Belgian climate change policies for the first commitment period 2008-2012 of the Kyoto Protocol), and the variety of policy questions it considers (integrated assessment of both climate change and acidification for the emissions of sulphate aerosols, the interaction of policy instruments like carbon taxes and emission permit trading, nonpoint source greenhouse gas (GHG) emissions from agriculture and so forth).

The core of the CLIMNEG 2 research network consists of a set of numerical simulation models that can be used to analyse a wide variety of policy questions related to climate change ranging from evaluating for the world level alternative burden sharing agreements for future commitment periods of a climate convention, to detailed simulations of cost efficient policies to reduce GHG emissions in the Belgian economy.

The CLIMNEG 2 proposal is organised around three major research themes. In the first major research theme of the proposal, *criteria for sustainable development*, we want to operationalise the concept of sustainable development in the context of climate change. The project will not provide a definite answer to the difficult question of defining sustainable development. Instead, the analysis will identify minimal requirements (necessary but probably not sufficient conditions) a sustainable economic development should satisfy. These conditions will be derived from a theoretical welfare economic analysis of the trade off between the fundamental concepts of (1) economic efficiency, (2) environmental sustainability, (3) intragenerational and intergenerational equity, and (4) implementation and strategic stability of post-Kyoto climate agreements.

The second major research theme will focus on *climate policy instruments* and in particular on the combination of tax instruments and emission trading, the use of specific price instruments for GHG emissions resulting from agriculture (nonpoint source pollution), the microstructure, initial allocation and trading rules of GHG emission permit markets. For the purpose of this research theme, a portable simulation tool will be developed for analysis of GHG emission trading under different institutional regimes (number of participants, trading ceilings, banking, market power etc.).

Thirdly, the CLIMNEG II project contains an important *integrated assessment modelling* effort. The project will refine and update several models that are currently available in the network (the integrated assessment model CLIMNEG World Simulation CWS model, the general equilibrium model GEM-WORLD, the Belgian MARKAL energy system model). The project will create “soft links” between the models in order to achieve consistency between the different levels of analysis. For the integrated assessment aspect of the project, interdisciplinary contributions from agricultural sciences and climatology are called upon. The agricultural economics contribution consists of providing model input for non-CO_2 emission processes and abatement cost functions related to agricultural production. Concerning climatology, the CLIMNEG 2 proposal will refine the carbon cycle and regional temperature change module of the existing CWS model by allowing for a multi-gas approach and by adding a sea-level module. The climate team will also contribute to the identification of criteria for sustainable development by providing a family of GHG emission trajectories leading to a stabilisation of GHG concentrations at levels that prevent irreversible damage to the Earth's ecosystems. Finally, the project will consider the possibility of linking a medium sized physical model (MoBidiC) to a general equilibrium model of the world economy, e.g. GEM-E3-WORLD.

Conclusion

With the financial means set at the disposal of the CLIMNEG research team, not only pre-existing research on climate affairs was allowed to be pursued in Belgium, but new research has been developed.

Interdisciplinarity is probably the most prominent characteristic of this new stage; it may also be considered as the most important as it was non existent beforehand. Obvious results of that are the greater attention attached by scientists in Belgium to the socio-economic implications of climate change policies, as well as the greater concern by Belgian social and economic scientists for the climate change problem.

A further result, specific to the CLIMNEG project, is that a team of increasingly competent persons has been formed, many of which are outside of CLIMNEG today but exert usefully their competence in a variety of institutions. Building this kind of capacity is probably a major and long lasting benefit of the project, for the community at large.

Last but not least, the scientific contributions themselves should have lasting effects. Those, to be judged by the publication record, cannot be seriously ascertained at this stage, given the long delays prevailing.

References

Alcamo, J., (ed.) IMAGE 2.0 - Integrated Modelling of Global Climate Change (Kluwer Academic Publishers, Dordrecht) (1994) 321 p.

Chwe, M. S.-Y., Farsighted coalitional stability, *Journal of Economic Theory* 63, (1994) 299-325

d'Aspremont, C., Jacquemin, A., Gabszewicz, J.J., en Weymark, J. On the stability of collusive price leadership, *Canadian Journal of Economics* 16 (1983) 17-25

Dowlatabadi, H., Integrated assessment models of climate change, *Energy Policy* 23 (1995) 289-296

Janssen, M., *Modelling Global Change - the art of integrated assessment modelling* (Edward Elgar, Cheltenham), (1998) 262 p.

Kolstad, C., and Toman, M., The economics of climate policy, Discussion Paper 00-40 (2000) (Resources for the Future, Washington), http://www.rff.org

Kverndokk, S., Fankhauser, S., The Global Warming Game - Simulations of a CO_2 Reduction Agreement, *Resource & Energy Economics* 18(1), (1996) 83-102

Manne, A., Mendelsohn, R., and Richels, R. MERGE, A model for evaluating regional and global effects of GHG reduction policies, *Energy Policy* 23, (1995) 17-34

Nordhaus, W. Rolling the DICE, an optimal transition path for controlling greenhouse gases, *Resource and Energy Economics* 15, (1993) 27-50

Nordhaus, W., and Yang, Z., (A regional dynamic general-equilibrium model of alternative climate-change strategies, *The American Economic Review* 86, (1996) 741-765

Tol, R., On the Optimal Control of Carbon Dioxide Emissions -- An Application of FUND, *Environmental Modelling and Assessment* 2, (1997) 151-163

Weyant et al., Integrated assessment of climate change: an overview and comparison of approaches and results, in: Bruce, J.P. et al. (eds), *Climate Change 1995: Economic and Social Dimensions of Climate Change*, Contribution of Working Group III to the Second Assessment Report of the Intergovernmental Panel on Climate Change (Cambridge UP, New York), (1996) 366-439

CLIMNEG WORKING PAPERS

N°1: GERMAIN M., TOINT Ph. and TULKENS H., 1997, "Financial Transfers to Ensure Cooperative International Optimality in Stock Pollutant Abatement" , published as chapter 11 in Faucheux S., Gowdy J. and Nicolai I. (eds), *Sustainability and Firms: Technological Change and the Changing Regulatory Environment*, Edward Elgar, Cheltenham, 205-219, 1998.

N°2: GERMAIN M., TULKENS H. and DE ZEEUW A., 1996, "Stabilité Stratégique en Matière de Pollution Internationale avec Effet de Stock: le Cas Linéaire", published in la *Revue Economique*, Paris, 49 (6), 1435-1454, 1998.

N°3: CURRARINI S. and TULKENS H., 1998, "Core-Theoretic and Political Stability of International Agreements on Transfrontier Pollution". (Also available as *CORE Discussion Paper* n° 9793)

N°4: TULKENS, H., 1997, "Cooperation vs. Free Riding in International Environmental Affairs: Two Approaches", published as chapter 2 in Hanley, N. and Folmer, H. (eds), *Game Theory and the Environment*, Edward Elgar, London, 30-44, 1998.

N°5: CHANDER, P., 1998, "International Treaties on Global Pollution: a Dynamic Time-Path Analysis", appeared in Ranis, G. and Raut, L. K. (eds), *Festschrift in Honor of T.N. Srinivasan*, Elsevier Science, Amsterdam. (Also available as *CORE Discussion Paper* n° 9854)

N°6: GERMAIN M., TOINT Ph., TULKENS H. and DE ZEEUW, A., 1998, "Transfers to Sustain Core-Theoretic Cooperation in International Stock Pollutant Control". (Also available as *CORE Discussion Paper* n° 9832)

N°7: BERTRAND, C., 1998, "A Short Description of the LLN-2D Global Climate Model", mimeo.

N°8: TULKENS, H. and VAN YPERSELE, J.-P., 1997, "Some Economic Principles for Guiding International Cooperation on the Issues Raised by Climate Change", handout for a lecture delivered at the "Global Change Workshop MIT-UCL", Petrofina, Brussels.

N°9: VAN YPERSELE, J.-P., 1998, "La Contrainte Climatique et le Protocole de Kyoto", communication au Symposium "Le Protocole de Kyoto: contrainte ou opportunité? Le défi des changements climatiques", Conseil Fédéral du Développement Durable, Bruxelles.

N°10: EYCKMANS, J., 1999, "Strategy Proof Uniform Effort Sharing Schemes for Transfrontier Pollution Problems", published in *Environmental and Resource Economics,* 14, 165-189.

N°11: CHANDER, P. and KHAN, M.A., 1998, "International Treaties on Trade and Global Pollution". (Also available as *CORE Discussion Paper* n° 9903)

N°12: CHANDER, P., TULKENS, H., VAN YPERSELE, J.-P. and WILLEMS, S., 1998, "The Kyoto Protocol: An Economic and Game Theoretic Interpretation", to be published in Dasgupta P., Kriström, B. and Löfgren K.-G. (eds), *Environmental Economics – Theoretical and Empirical Inquiries: Festschrift in Honor of Karl-Göran Mäler*, forthcoming Edward Elgar. (Also available as *CORE Discussion Paper* n° 9925)

N°13: BERTRAND, C., VAN YPERSELE, J.-P. and BERGER, A., 1998, “Volcanic and Solar Impacts on Climate since 1700”, published in *Climate Dynamics*, Springer-Verlag, 15, 355-367, 1999.

N°14: EYCKMANS, J. en PROOST, St., 1998, “Klimaatonderhandelingen in Rio en Kyoto: een Successverhaal of een Maat voor Niets?” (Also available as *Leuvens Economisch Standpunt* n° 1998/91, Centrum voor Economische Studiën, Katholieke Universiteit Leuven, 1998)

N°15: D’ASPREMONT, Cl. and GERARD-VARET, L.-A., 1997, “Linear Inequality Methods to Enforce Partnerships under Uncertainty: An Overview”, published in *Games and Economic Behavior* 25, 311-336 (1998).

N°16: BERTRAND, C. and VAN YPERSELE, J.-P., 1999, “Potential Role of Solar Variability as an Agent for Climate Change”. *Climatic Change*, 43, 387-411, 1999.

N°17: D’ASPREMONT, Cl., 1998, “La Justice entre les Générations”, published in *Reflets et Perspectives de la Vie Economique* (Brussels), 38 (1), 11-14, 1999.

N°18: EYCKMANS, J. and TULKENS, H., 1999, “Simulating with RICE Coalitionnaly Stable Burden Sharing Agreements for the Climate Change Problem”. (Also available as *CORE Discussion Paper* n° 9926)

N°19: GERMAIN, M. and VAN YPERSELE, J.-P., 1999, “Financial Transfers to Sustain International Cooperation in the Climate Change Framework”. (Also available as *CORE Discussion Paper* n° 9936)

CLIMNEG-CLIMBEL WORKING PAPERS

N°20: VAN STEENBERGHE, V., 1999, "La Conception d'un Marché Domestique de Droits d'Emission de Gaz à Effet de Serre : Aspects Economiques", miméo.

N°21: BERTRAND, C. and VAN YPERSELE, J.-P., 1999, "Development of a New Climate Module for the RICE/DICE Model".

N°22: MILCHTAICH, Igal, 1999, "How Does Selfishness Affect Welfare?" (Also available as *CORE Discussion Paper* n° 9954)

N°23: BOUCQUEY, N., 1999, "L'Organisation d'un Marché de Permis Négociables: Notions Pertinentes en Droit Privé" (version provisoire – draft).

N°24: GERMAIN, M., LOVO, S. et VAN STEENBERGHE, V., 2000, "De l'Importance de la Microstructure d'un Marché de Permis de polluer".

N°25: BERNHEIM, Th. and GOUZEE, N., 1999, "A Sustainable Development Approach to Climate Change: Why and How?"

N°26: GERMAIN, M., TOINT Ph. et TULKENS H., 1999, "Transferts Financiers et Optimum Coopératif International en Matière de Pollutions-Stocks", publié dans *L'Actualité Economique. Revue d'Analyse Economique*, 75 (1-2-3), 427-446, 1999. (Version en langue française du CLIMNEG Working Paper N° 1.)

N°27: RAY, I., 2000, "Game Theory and the Environment: Old Models, New Solution Concepts".

N°28: BERNHEIM, Th., 2000, "Voortgang in de Internationale Samenwerking voor de Beheersing van de Klimaatproblematiek. Een Stand van Zaken." (Pedagogisch Fiche n° 1)

N°29: BERNHEIM, Th., 2000, "Verhandelbare Emissierechten en Geografische Flexibiliteit voor Reducties in Broeikasgassen: De Kyoto-Mechanismen." (Pedagogisch Fiche n° 2)

N°30: BERNHEIM, Th., 2000, "De Inzet van Fiscale Instrumenten in het Klimaatbeleid: Theoretische Concepten en Praktische Uitvoering." (Pedagogisch Fiche n° 3)

N°31: BERNHEIM, Th., 2000, "Het Gebruik van Regulerende Instrumenten in het Nationale en het Internationale Klimaatbeleid." (Pedagogisch Fiche n° 4)

N°32: EYCKMANS, J. and BERTRAND, C., 2000, "Integrated Assessment of Carbon and Sulphur Emissions, Simulations with the CLIMNEG Model." (Also available as *ETE Working Paper* n° 2000-08, Centrum voor Economische Studiën, Katholieke Universiteit Leuven, 2000)

N°33: EYCKMANS, J. and CORNILLIE, J., 2000, "Efficiency and Equity in the EU Burden Sharing Agreement." (Also available as *ETE Working Paper* n° 2000-02, Centrum voor Economische Studiën, Katholieke Universiteit Leuven, 2000)

N°34: BOUCQUEY, N., 2000, "L'Organisation du Marché des Permis Négociables. L'Emergence de Marchés et les Problèmes de Concurrence."

N°35: DELCOURT, R., 2000, "L'Organisation du Marché des Permis Négociables. Développement des Aspects de Droit Bancaire et Financier pour le Permis Négociable."

N°36: VAN YPERSELE, J.-P., 1999, "Modélisation des Changements Climatiques Futurs au Carrefour d'une Recherche Fondamentale en Environnement et d'une Recherche Socio-Economique en Appui à la Décision", publié dans les Actes du Symposium "A la Recherche d'un Dialogue Durable entre Science et Politique" des 24 et 25 novembre 1999, Services Fédéraux des Affaires Scientifiques, Techniques et Culturelles (SSTC), Bruxelles.

N°37: BERNHEIM, Th., 2001, "Vrijwillige Overeenkomsten als Instrument in het Klimaatbeleid, Mogelijkheden en Beperkingen." (Pedagogisch Fiche n° 5)

N°38: BERNHEIM, Th., 2000, "Communicatieve Instrumenten in het Nationale en Internationale Klimaatbeleid, Uitvoering aan de Hand van de Overdracht van Technologie en Capaciteitsopbouw." (Pedagogisch Fiche n° 6)

N°39: GERMAIN, M. and VAN STEENBERGHE, V., 2001, "Constraining Equitable Allocations of Tradable Greenhouse Gases Emission Quotas by Acceptability."

N°40: EYCKMANS, J., 2001, "On the Farsighted Stability of the Kyoto Protocol".

N°41: PROOST, St. and VAN REGEMORTER D., 2000, "How to achieve the Kyoto Target in Belgium – Modelling Methodology and Some Results".

N°42: CHANDER, P. and TULKENS, H., 2001, "Limits to Climate Change", paper presented at the Sixth CORE – FEEM - GREQAM – CODE Coalition Formation Workshop held at Louvain-la-Neuve, January 26-27, 2001.

N°43: GERMAIN, M. and VAN STEENBERGHE, V., 2001, "Optimal Policy with Tradable and Bankable Pollution Permits: Taking the Market Microstructure into Account".

N°44: GERMAIN, M., TULKENS H., TULKENS Ph. and VAN YPERSELE, J.-P., 2001, "Side Payments to Ensure International Cooperation in a Regionalised Integrated Assessment Model of Climate Change" (forthcoming).

N°45: VAN IERLAND, W., 2001, "Insights in the Economics of Climate Change and its Solution" (forthcoming).

N°46: VAN IERLAND, W., 2001, "Emissiehandel Binnen het Belgische Klimaatbeleid: een Analyse van de Mogelijkheden en de Beperkingen" (forthcoming).

N°47: BERNHEIM, Th, 2001, "Coopération Internationale et Instruments pour la Prise de Décision dans le Cadre de la Politique Climatique", version française des "fiches pédagogiques" contenues dans les CLIMNEG-CLIMBEL Working Papers nos 28, 29, 30, 31, 37 et 38, publié dans *Planing Papers* Nº 89, Bureau Fédéral du Plan, Bruxelles, août 2001.

Systems science and social significance

(or) Why stakeholder concertation is impossible, necessary and desirable for integrated water resources management

Martin O'Connor

Professor in Economic Science,
Université de Versailles St-Quentin-en-Yvelines
47 boulevard Vauban, Guyancourt 78047 cedex, France
Martin.OConnor@c3ed.uvsq.fr

Key words:

Coexistence, Complexity, Deliberation, Distributional justice, Diversity, Environmental values, Externalities, Fairness, Future generations, Governance, Information society, Integrated assessment, Reciprocity, Reconciliation, Social costs, Stakeholders, Sustainability, Uncertainty, Water resources

Preface

Governance of common property water resources for sustainability requires — explicitly or implicitly — processes of arbitrage between different interests, conflict management and, where possible, reconciliation of multiple criteria for "good water quality". This means attention to tensions between preoccupations of, and for present and future generations, different economic sectors and interests in human societies today, between human and non-human communities…

Prospects for the reconciliation of different interests are often far from evident. Many different principles, justifications and ethics about what is fair and right, can and will be put up for consideration. Where a single method or principle of good water resource management does not prevail, a reasoned and robust base for regulation of resource use must have a reflexive deliberative character. In the search for a possible coexistence of the various interests, the challenge then is to work with a permanent "argumentation" between many contradictory principles of conduct and positions. In this process, social relations and the human sentiments can be as much the key to the emergence of reasonable" outcomes as good economic and environmental systems data.

John Commons, in Institutional Economics (1934, p.712), taking the cases of legal tribunals, offered the following plea for a process view of economic reasons and reasoning:

> *"The Court enters beneath the letter of the law and investigates the economic circumstances out of which the conflict of interest arises. Each dispute is a separate case with its own facts, although these facts may be brought within general principles and reconciled with particular precedents discovered in similar cases. The general weighing of all the facts thus investigated, in view of all these principles and precedents, is the process of deciding what is reasonable under all the circumstances."*

In this paper, after evoking rapidly this political philosophy and economic science problematic (Part I), a sketch is given of methodology for exploitation of the new digital information communication technologies (ICT) in the concerted governance of environmental problems (Part II). The example of aquifer water resources is developed to illustrate prospects for "revealing the social demand for reconciliation" and dealing in a deliberative way with the feasibility (systems potential) and desirability (social choice) questions that arise (Part III).

The presentation is partly based on methodology and results of the GOUVERNe research project.[22] GOUVERNe aims at the development and pilot implementation of user-based and scientifically validated Decision Support Systems (DSS) that can aid the integrated management of underground water resources through the mobilisation of information and judgement through stakeholder concertation. Decision support is understood as not only the acquisition, scientific validation and organisation of information, but also procedures for effective exploitation of this information by users. The envisaged DSS will combine spatial representation, scenario

[22] *GOUVERNe* stands for "Guidelines for the Organisation, Use and Validation of information systems for Evaluating aquifer Resources and Needs", a R&D project financed under the European Commission's Fifth Framework Programme in the field of research, technological development and demonstration, under the ENERGY, ENVIRONMENT AND SUSTAINABLE DEVELOPMENT theme, Key Action 1 : Sustainable Management and Quality of Water, RTD Priority 1.1.3 — Operational management schemes and decision support systems.

simulation, multiple criteria evaluation and interactive user-friendly interfaces. For the four selected case studies, each implementation will furnish a validated scientific support for debate and deliberation — by decision makers and stakeholders — permitting intelligent compromises, reduction of risks, identification of novel management options and, to the extent possible, co-operative conflict resolution.[23]

PART ONE - THE PROBLEM OF SOCIAL CHOICE, REVISITED [24]

> "It may be imagined, perhaps, that the law has only to declare and protect the right of every one to what he has himself produced, or acquired by the voluntary consent, fairly obtained, of those who produced it. But is there nothing recognised as property except what has been produced? Is there not the earth itself, its forests and waters, and all other natural riches, above and below the surface? These are the inheritance of the human race, and there must be regulations for the common enjoyment of it. What rights, and under what conditions, a person shall be allowed to exercise over any portion of this common inheritance cannot be left undecided. No function of government is less optional than the regulation of these things, or more completely involved in the idea of civilised society."
>
> *- John Stuart Mill (1848, 7th edition 1871/1909, p.797), Principles of Political Economy, with some of their applications to social philosophy.*

Introduction

Amongst economists, our habit is to frame resource management analyses in terms of "supply" and "demand". On the supply side, the problem is to define the frontiers of what is feasible for the economy and, more especially, the trade-offs (opportunity costs) imposed by the limits to what is feasible. On the demand side, the problem is to assess what will be judged desirable by members of the society.

In the case of a dam, or a motorway, or a forest exploitation scheme, or a fisheries management regime (etc.), or the introduction of genetically modified organisms, or the allocation of scarce aquifer water between users of different types and in different places, there are a variety of uncertainties about outcomes yet one thing is sure — there will be winners and losers and, moreover, the question of fairness and duties is often in dispute. The decisions and governance processes will in this respect involve what Institutional economists Warren Samuels and Allan Schmid call sacrificial or moral choices (Samuels & Schmid, eds., 1981).

Traditional concerns with productive efficiency, resource discovery and technological progress have put the emphasis on getting onto the frontier of feasibility and, going beyond, pushing out

---

23 In particular, *GOUVERNe* sets out to demonstrate feasibility of new ICT for user-friendly interactive stakeholder-based decision support. In this respect it is allied to and reinforced by another project, **ViRTUALiS** *(Social Learning on EnVIRonmental Issues with the eractive Information and CommUnicAtion TechnoLogIeS)* also led by the C3ED and funded by the European Commission's User-Friendly Information Society Technology programme. The latter project brings together a consortium of specialists in information technology, sustainable development, environmental modelling, public policy and governance, learning psychology and open learning, to develop computer-based learning tools on ecosystems and natural resources. Taking four domains as exemplary — agricultural pollution, climate change, freshwater resources and marine capture fisheries — **ViRTUALiS** is creating interactive learning tools for improving citizens' awareness of environmental management and risks.

24 Parts I and II of the paper are substantially based on sections of M. O'Connor (2001), "Social Costs and Sustainability", forthcoming in Daniel W. Bromley & Jouni Paavoli (eds., 2001), Economics, Ethics and Environmental Policy : Contested Choices, Edward Elgar, Cheltenham.

the frontier of possibilities. In the sustainability context, however, there are no “free access” resources any more the core question is "what, and for whom?" and the focus must be on deciding which feasible production and consumption, distributed between various different groups of "us" and "them".

For example, establishing a justification to build or not to build a water distribution system or a dam, depends on what forms of life and social relations shall be sustained, and what shall be foreclosed (cf. McCully 1996; also the recent work of the World Commission on Dams). What is the basis for resolving the ownership, rights, duties, or wider distributional conflicts? How might considerations of desirability, which differ from "us" to "them" and from group to group within society, be expressed and reconciled?

The Impossible Problem of Social Choice

Notwithstanding disciplinary attempts at separating the “positive” from the “normative”, policy economists cannot avoid examining the societal basis, for any significant resource management problem, for resolving a "just" or "good” distribution. The attempted axiomatisation of this abstract social choice problem, as formulated by Kenneth Arrow, led to an apparent impasse, the so-called Impossibility results (see Arrow 1963; also Sen (1970). Briefly, and roughly speaking:

- If the attempt is made to advise on what is “best” for the society, on the basis of a “general” rule (or set of criteria), then the choice comes down to one between Dictatorship or Inconsistency;
- If both Dictatorship and Inconsistency are to be avoided by weakening the rule system, then either the advice may be indecisive or the possibility is opened of dishonourable outcomes.

There is, nonetheless, a quite simple way of moving forward. This is to reframe the Impossibility results, taking them as hints of a probable deep structural property of situations of human coexistence and co-ordination. The suggestion is to recognise that people (including ourselves) are indeed un-reconciled, not only to each other but often also within themselves, and that being "shot through with contradictions" is part of being human in society. This does not mean that "anything goes" (in the much-misunderstood phrase of Paul Feyerabend). Rather, it follows — as Feyerabend indeed would insist — that there may coexist a plurality (perhaps irreducible) of evaluation or justification principles that — while being all pertinent in some way(s) — cannot all be applied simultaneously (or, at best, may lead to divergent recommendations).

In other words, it can be reasonable not to be rule-bound. This can be vexatious, but it is not really such a new problem for economists. John Stuart Mill had many times encountered it (see O'Connor 1995, 1997); environmental philosophers currently discuss it (e.g., Holland 1997; Stone 1987). Several generations of institutional economists such as Commons (1924, 1934), Kapp (1968, 1969), Schmid (1978), Bromley (1989) and Samuels (1992) have insisted on the importance of empirical and theoretical analysis of the instituted processes of working out responses to co-ordination dilemmas.

For example John Commons, in his *Institutional Economics* (1934, p.712) well in advance of Arrow's mathematical axiomatisation, had insisted that no "general" formula could be relied upon to produce "reasonable" in application to all sets of problems of fairness and justice in resource allocation. Reasoned and reasonable compromises would have to be deliberated and worked out in a permanent social process. Moreover, this permanent working out of our coexistence problems centres around the substance and significance given to redistribution of risk and economic opportunities — what Samuels later calls the "distribution of sacrifice" — at any moment in time and projecting into the future.

Determining what might be feasible in ecological economic futures is partly a matter of science and technological know-how. But uncertainties abound. The "space of feasible outcomes" is characterised ex ante by an inherent indeterminacy and ex post by irreversibilities. Knowledge in the sense of insight and understanding is absolutely not synonymous with capacity for predictions. Awareness of risks is not synonymous with capacity to intervene to reduce or control the risks. Examples currently in the news, include greenhouse gas emissions into the atmosphere and perturbations to climate patterns; cloning processes where the transmission of cell "biological age" is a complex phenomenon; medical drugs whose "side-effects" are unpredictable in time and from one species to another; genetic splicing and eventual population biology consequences (including the possible cross–fertilisation of genetically modified and non-modified strains of commercial food plants); nuclear fuel cycle experiments; new chemicals produced, or by-produced, for industrial processes.

Many scientists will argue that ignorance and incompleteness of knowledge have always been admitted within the scientific project. At stake, however, is not the admission of partial ignorance but, rather, the significance to be attached to the forces of change being engaged under conditions of inability to exercise mastery over eventual outcomes (Funtowicz & O'Connor 1999; Gallopin, et al., 2001).

For example, we can observe that the question of society's attitude(s) towards technological progress tends to polarise around a question of the burden of proof.

- Those evoking the traditional discourses of progress and perfectibility (and others invoking mere adventurism) will argue that "the future can look after itself" and that all risks should be run.
- Those evoking a "precautionary" attitude will argue about the risk of so-called "Type II Error", emphasising that absence of proof of danger is not the same as proof of the absence of danger. Where uncertainty and possibly grave dangers reside, the risk should not be run.

Neither of these positions, in their pure forms, is satisfactory. Often, it is not possible to furnish definitive proof of danger, nor definitive proof of non-danger. Some risks must be run (otherwise there are the dangers and contradictions of paralysis...). Yet, a heedless rush into ecological, geophysical, metabolic and chemical novelty seems (to many people) an excessive enthusiasm for making trouble.

So, we have an interesting — some would say impossible — situation where neither rule can, strictly speaking, be applied; yet each precept acts as a caution on (or, indeed, a refutation of) the other, creating a sort of dilemma or impossibility. This is the hallmark of environmental governance problems. It is, in other words, impossible to go beyond this sort of situation of contradictory imperatives, or contradictory counsels of "good reasons".

This does not mean that a "reasoned" base for policy is impossible. Rather, if reasoned basis for action is to be established, then forms of deliberative and regulatory procedure are wanted that "relativise" the contradictory positions while not seeking entirely to dispose of any of them. The challenge would be to work with a permanent "argumentation" between the two — or more — contradictory positions. An analyst in such circumstances needs to be like a "midwife of problems" (Rittel 1982, pp.35-48), helping to raise into visibility, "questions and issues towards which you can assume different positions, and with the evidence gathered and arguments built for and against these different positions".

Pragmatic Justifications for Deliberation on Sustainability

Environmental resource management is, par excellence, the domain of "common problems" — that is, situations of strong and visible interdependence between individual and collective actions, characterised by the Prisoners" Dilemma. The resolution of such problems means to be dealing incessantly with moral choices, and this makes calculation, measurement and technical expertise on their own insufficient. Decision quality assurance and socially legitimate governance processes can be assured only through integrating scientific, technical and economic expertise within a permanent stakeholder communication process, in order to search for common ground.

From this point of view, the typical sustainability "social choice" problem — characterised by distributional conflicts and uncertainty — appears to lead to a bifurcation point, where a person or group will be required to choose between two forms of discourse and action:

- On the one hand, discourses (usually seeking to be translated into practices) of Domination, corresponding to Arrow's notion of Dictatorship. This means the exclusion or discounting of any contradictory principles of what is good and should be done, a purely strategic concern (in order better to dominate) any evidence of "other points of view".
- On the other hand, discourses taking up a challenge of tolerance — proposing to search out possibilities of Co-existence based on respectful consideration of a plurality of antagonistic or seemingly contradictory considerations. As the Buddhists say, "Do not take life unnecessarily."

Taking up the second option, one looks for the possibilities of dialogue, reciprocal learning, accommodations and adaptation, and discursive and deliberative processes for making visible the diversity and seeking a reciprocal awareness — even a reciprocal evaluation! — of the plurality of "reasonable" claims and (sometimes incompatible) points of view. But, this merely puts on stage the problem of coexistence; it may highlight the tensions and the contradictions, it does not in itself put an end to them (Latouche 1984, 1989; O'Connor 1999a, 2000; Salleh 1997). In this regard, as Latouche (1989, p.139) suggests, the conviction in the merits of a philosophy of coexistence can arise almost paradoxically:

> "…as there is no hope of founding anything durable on the short-change of a pseudo-universality imposed by violence and perpetuated by the negation of the other party, the venture is warranted that there is indeed a common space of fraternal coexistence yet to discover and construct."

There will evidently be many situations where people, or different cultures, or different species of plants and animals, simply can not, or do not want to, find a basis for durable coexistence. So reflective deliberation as advocated here, may work to highlight appreciation of tensions, but it does not necessarily find a way to put an end to them. The Coexistence ideal of a dignified compromise does not mean finding, by some magical process of option creation, a win-win outcome where everyone takes away from the negotiating table a large part of what they came to bargain for. A coexistence ethic does not necessarily make for easy living. Rather, it means reciprocal consideration, willingness to accept sacrifices for a good cause, the ability to refine and change one's personal (or group, or national) goals in the interests of wider community.

PART TWO - ELEMENTS FOR INTEGRATED ENVIRONMENTAL ASSESSMENT

The Semantic Field of Sustainability

What are the prospects for social learning, participatory and deliberative procedures for decision support, policy definition and evaluation, such that people may be encouraged, one and all, to "jump out of the Prisoners" Dilemma" (Guimarães Pereira & O'Connor 1999)? There is currently much debate over the extent to which democratic political process can or should allow for reflective deliberation, and how this might be reflected in pursuit of sustainability (e.g., Dryzek 1994; Holland 1997; Sagoff 1998). The variety of participative and deliberative procedures is very wide, however one widespread feature is the emphasis on tolerance and coexistence of divergences. At the heart of any notion of democracy or deliberation, is the admission of a plurality of potentially “reasonable” views and claims on the situation, which should be listened to, before rushing to a decision.

Principle 10 of the UNCED Declaration made at Rio de Janeiro in 1992, affirmed that "environmental issues are best handled with the participation of all concerned citizens, at the relevant level" (cf. Brodhag 1999). Yet, learning about economic and environmental issues involves the confrontation with a diversity of objectives and interests which are expressed in a variety of vocabularies and at different scales. Information and communication frames must be developed not just with a view to scientific validity, but also from the standpoint of the ways that they help (or don't help) to "set the stage" for convivial exchanges of perspectives. What is most critical is appreciation of the significance to different groups and persons of alternative resource management choices (or even, in some cases, choices to not manage particular processes, ecosystems and resources).

The schematic layout below highlights the complementarity between, on the one hand, investigations of systems potentials or feasibility, and, on the other hand, investigations of the criteria of desirability or social choice for various feasible courses of action.

SYSTEMS SCIENCE (Feasibility)	**Information, Indicators (and Uncertainties)**	**(virtual) ICT INTERFACES**	**Social Actors (stakeholders)**	**SOCIAL SIGNIFICANCE (Desirability)**
Knowledge, Resources and Techniques	**Analytical Methods for Option Appraisal**	***(real)*** *POLICY ISSUES* **(Sustainability of what and for whom?)**	**Motivations, Interests and Justifications**	**Ethics, Culture and Values**

The Systems Potential aspect can be seen as a generalisation of the traditional economics question of supply costs, adapted to the long-time-scales and larger systems perspectives that characterise sustainability concerns. Economic resource management must fulfil two complementary functions. The first is the delivery of economic welfare in the narrow sense, through production of economic goods and services; the second is the maintenance of the ecological welfare base through assuring reproduction or enhancement of critical environmental functions.[25] Policies aimed at safeguarding the support functions of the environment, require the

[25] Environmental functions are here defined as any capacity or performance of natural processes which assures the permanence of living ecosystems and/or furnishes goods and services of value to human society. The justifications for produced economic output and the maintenance of environmental functions as complementary sustainability criteria — the so-called 'strong sustainability' perspective — are developed by, among others, Hueting (1980), Faucheux & O'Connor (eds., 1998; 2001); and Ekins & Simon (1999).

commitment (or reorientation) of scarce resources. Sustainability objectives can thus be thought of as responding to a kind of social demand for the maintenance of environmental functions. As discussed in Part One, this social demand for environmental quality and for assuring fairness towards future generations (including protection from future harms), cannot easily be reduced to simple monetary values. Rather, scenarios exploring different conceivable co-evolutions of ecological and economic systems, need to be formulated and evaluated from various points of view. These include scientific preoccupations such as sensitivities to speculative hypotheses about technological capacities and ecological systems changes, and also societal preoccupations that can be summarised in the phrase "Sustainability of what, and for whom?". These analyses will usually entail various forms of systems representation, simulation modelling and quantification that integrate economic and ecological components, notably:

- statistically aggregated economic information — such as systems of accounts and models quantifying volumes of sectoral production, water use and greenhouse gas emissions on a national, regional or world basis;
- spatially defined environmental information — such as an aquifer or watershed, or the global atmosphere considered as a fluid dynamic circulation system, coupled to the oceans, which is being "forced" by the inflow of anthropogenic greenhouse gases.

This is the realm now known as integrated modelling, combining ecological and economic dimensions, and which has now become a major activity of inter-disciplinary policy-relevant research endeavour.

The Social Choice problem is to decide what might be desirable within the bounds of the feasible. Abstractly, this takes on the form of an arbitrage between different interests, just as in Arrow's classic formulation. Following the Brundtland formulation (WCED 1987), we can consider the specific problematic of sustainability as a tension between present and future generations. And, in the context of environmental valuation problematics, this in turn can be seen as one aspect of a more generalised structural opposition — between "us" and the "others", between self-interest and interest in the livelihoods of others, between human and non-human communities, between "our" culture (whichever it is) and other cultures, and so on (see Arnoux et al. 1993; Salleh 1997; O'Connor 1994, 1999b; Hailwood 2000). The variety of candidate sustainability ethics that, over the years, have been put forward, tend indeed to turn around this time-honoured problem of reconciling concern for oneself with a consideration for the other(s).

This suggests that two forms of social information or representation will have special pertinence for a de liberative approach to resource valuation and governance:

- local-level information — that is, the immediate life experience of "ordinary" members of society in their homes, workplaces, farms, shops, schools, with friends and on their travels;
- governance information — the terms in which a regulation and co-ordination of human action is conceived, which link local and aggregated economic and ecological information to frameworks of collective purpose, responsibilities, conflict management and policy implementation.[26]

[26] It has become commonplace to refer to economic, ecological and social dimensions of sustainability. The 'social' dimension has often rested rather amorphous, and often drifts back towards economic information such as employment, income and property ownership. More recently, though, emphasis has been placed on the political/institutional dimensions. For example the FAO (1999) in work on indicator systems for sustainability management of fisheries, designates Economic, Social (local), Ecological and Governance dimensions, thus giving attention to the institutional basis for resolving the problems of social choice. The formulation here corresponds to the "Tetrahedral Model" framework for integrated representation of systems potential (economy-ecosystem coevolution) and social choice problems (local stakeholder perceptions and societal coordination) as developed at the C3ED. The Tetrahedral framework is being applied as a guideline for the development of *ICT* in several domains, notably greenhouse gas emissions and climate policy (Guimarães Pereira & O'Connor, 1999), water and soil pollution from agriculture (Douguet, Girardin & O'Connor, 1999; Douguet & Schembri, 2000), marine fisheries and coastal ecosystems, forests, and underground water resources.

The above formulation thus distinguishes four basic dimensions of information — ecological and economic systems information, individual knowledge, and governance or institutional framing information. These may be considered as irreducible dimensions for building a good representation of an environmental issue. (There are, of course, many, many "local" standpoints.)

Representation and "Information Systems" for Stakeholder Concertation

The sustainability policy challenge is to find ways of representing the systems feasibility information in ways that might orient individuals towards an awareness of higher-level institutional processes of resource governance and motivate their contribution to this governance. This requirement can be summarised in the following formula:

A good representation must:

signal (or reinforce, etc.)

the existence or creation

of plausible and convincing institutional arrangements for

co-ordinating the actions of

all involved parties

in a fair and acceptable solution

for the pursuit of

the sustainability goals.

Many research, policy and educational groups are exploring prospects for the development of computer-based learning tools that can organise current scientific knowledge and portray governance issues for sustainability in ways useful to non-specialist audiences.[27] Although there is a great variety to the forms and frameworks that such representations may take, some principles seem robust. In the current C3ED work on interactive multi-media supports for deliberative resource governance, we insist on both "internal" considerations of scientific validation and "external" considerations of usefulness as a real deliberation and decision support tool in policy and management contexts.

First, what is required is a robust, and intuitively accessible, conceptualisation of the object requiring to be governed — for example, water resources and their users at the level of the catchment, aquifer and relevant territories of economic activity and for a determined horizon of time. Robust in this context means that the conceptual framework including portrayal of natural system dynamics and societal conflicts and priorities is accepted as plausible and legitimate by a wide range of stakeholders (including the scientific community itself).

[27] In the **ViRTUALiS** project led by the C3ED, four types of ICT tool are being developed: **Personal Barometers**, allowing quantification of environmental impacts of individual lifestyles; **Scenario Generators**, exploring changes in patterns of economic activity towards sustainable resource use; **Virtual Visits**, or interactive digital environments within which the learning may take place; and **Multi-player Games**, which allow individuals to learn about problems of governance and resource access. Using emerging ICT capacities, user-friendly interfaces and virtual worlds will allow structured learning about personal and aggregate societal impacts on environmental resources. Within interactive virtual realities, a user (or a group of users) can gauge how their personal way of living impacts on the environmental feature or resource in question (Personal Barometer), they can explore alternative possibilities for social and economic changes towards sustainability (Scenario Generator), they can experience the dilemmas of stakeholder negotiations and of commercial and public policy choices (Multi-Agent Games), and they discover opportunities for personal learning through progressive disclosure of links to electronic libraries, simulation models, videos, on-line data bases (Virtual Visit).

Second, admitting the complexity of the systems in question,[28] there must be transparency in the dialectical portrayal of what is known, of the dimensions of scientific controversy and uncertainty, and of the hypotheses about socio-economic trends and change.

Third, and as an extension of the first two, multi-media representations and "models" of whatever sort, must facilitate the collective "appropriation" of the resource management problems.

Making representations accessible to a variety of people means establishing "bridges" between representations at different levels of aggregation or based on varied conceptual frameworks.[29] It also means building the capacities for mutual understanding of the contrasting perspectives and preoccupations of different stakeholders, allowing them to identify, explore, argue about and debate the key scientific and socio-economic features of system behaviour and possible future directions in order — perhaps — to search for points of common ground.

As outlined below, we may approach this challenge in terms of scenario methodology, where the goal of the scenario work is the construction of a "virtual object" — the future as a fuzzy object — that can be a kind of stage prop for people to argue about. By debating the good and the bad of the future as a commonly envisaged fuzzy object, the participants contribute to the overall concertative governance process.

Deliberation in the "Theatre of Sustainability"

Our concern in the GOUVERNe project is with scientific support for governance challenges of underground freshwater resource exploitation and conservation. In a general way, policies for water system management (ecological conservation, irrigation, urban supply, industrial use, river water flow control, draining and building, sewage disposal and pollution monitoring and control, etc.) will involve choices for the redistribution through time of economic opportunity and of access to services and benefits provided by the biophysical environment. Water cycles and flow patterns, including the underground zones and transportation, are also part of the ecosystem infrastructures supporting habitats of mountainside, swamp, riverbank and aquatic species. The water may be a potentially valuable input for industrial, agricultural and urban consumption. But if aquifer reserves are exploited, or river water flow is diverted for irrigation, for factory use, for power plant cooling or for urban drinking supply purposes (for example), or if the continuity of flow is interrupted through dams, reservoirs and other forms of storage, the natural forms of life may be put at risk. Water that has been used for economic purposes may be allowed to flow back into natural systems in a dirtied or polluted condition; this also can menace the viability of life forms and can pose problems for human health.

The application of principles of stewardship, precaution and fairness in distribution may be explored in a general framework of scenario or "futures" studies. Tensions, conflicts of interests, uncertainties and dissent amongst scientists, as well as governance challenges, can be explored by cross-comparison of different scenarios about regimes of water resource use and corresponding institutional arrangements.

---

[28] For example, governance of the use of underground water resources is made complicated by the (inevitably) incomplete knowledge of their present and possible future aquifer behaviour, the linkages with surface waters, the time lags (which may be several decades) between resource exploitation and hydrosystem change and the indeterminacies of economic and land-cover futures...

[29] In the current C3ED work we specify two qualities that need to be satisfied by any representation or category of information (such as a number produced in a valuation study or an image on a video screen) if it is to perform effectively in the desired role of supporting stakeholder deliberation on sustainability problems. First, the indicator or image (etc.) should mark a *passage between different scales of representation* of an economic, ecological or political co-ordination situation (e.g. from an individual to a more aggregated perspective). Second, the indicator or image (etc.) ought *to speak meaningfully to at least two (or more) different categories of stakeholders*, viz., it ought to find a meaningful place within a plurality of distinct "life worlds" or decision contexts.

One set of scenarios would usually be trend-based or "business-as-usual" projections, which may often involve trends in water use that are unsustainable.

Other scenarios may then be constructed that involve the satisfaction of specific sustainable use criteria, based on various hypotheses about systems potentials and about social choices of "what, and for whom?".[30]

Having established the general conceptual orientation, the next task is to specify an institutional and deliberative context and to develop specific content for the scenario visions.

As a general procedure, information about interests and priorities can be built and debated in a "theatre of sustainability" — as suggested schematically by the diagram below. A stakeholder concertation process can be developed that integrates systems science with deliberation in a recursive cycle as follows:

STEP 1: Diagnosis of Stakeholder Interests and first specification of the resource management "problems to be solved".

STEP 2: Scientific Analysis of the Hydrological System (e.g., Hydro-system modelling, population ecology, etc).

STEP 3: Analysis in biophysical terms of the Environmental Functions of the resource (in the broad categories of Source, Sink, Site, Scenery, and Life-Support).

STEP 4: Quantification of Socio-economic Significance of Environmental Functions (viz., the services rendered to economic activity and human well being).

STEP 5: Economic analyses (cost and benefit assessments of options, constructed on a platform of Multi-Criteria Appraisal and Scenario Analyses.

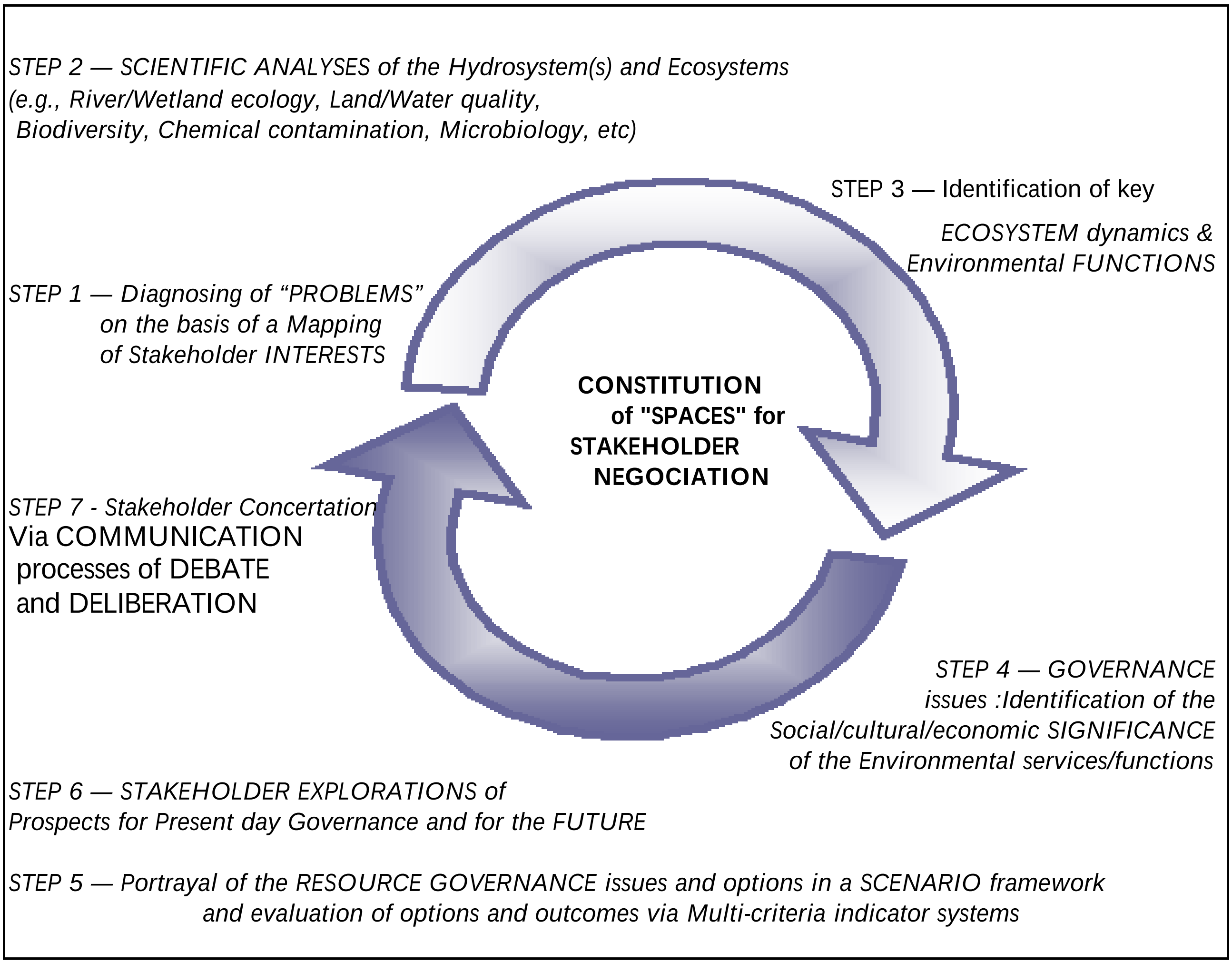
STEP 6: Communication of Results (resource management options, evaluation results, etc.).

STEP 7: Stakeholder appraisal of results, leading back to re-specification of problems and options.

The portrayal of an iterative loop is intended to emphasise the real-time process of putting onto the scene interests, knowledge, disagreements and possible solutions. The first step in the cycle privileges the Social Choice (or desirability) preoccupations at the stakeholder level; the next four steps privilege the Systems Potential (or feasibility) aspect of analysis, and the last two steps again privilege the Social Choice problem, this time at the governance level.[31]

[30] This new style of scenario based evaluation can be seen as an extension to new terrain, of well-established fundamentals of welfare economics concerning the inseparability of allocative (efficiency) and distributional (equity) goals. The extension takes into account two key points: (1) The further that concerns of environmental policy extend to the long term future, the more will inter-temporal distributional considerations predominate over allocative efficiency in policy formulation and appraisal; (2) The further that concerns for environmental values extend into the domains of aesthetic and cultural as well as economic appreciation of natural cycles and systems, the more difficult it becomes to obtain meaningful monetary valuation estimates based on the assumptions of value-commensurability and substitutability that underlie established CBA approaches. Sustainability evaluation studies require three tiers (cf. O'Connor & Martinez-Alier 1998; O'Connor 2001). First, the normative dimension inherent in the sustainability referent, is reflected in the way that scenarios are formulated explicitly as respectful, or not, of fundamental notions of social, economic and ecological sustainability. Second, substantive attention is given to inter-group and intra-generational distribution issues by the requirement to give a specific content to the sustainability goal, through description of, and analysis of possible incompatibilities between the diverse sustainability concerns expressed by the variety of stakeholders. Third, opportunity costs for alternative water uses can be estimated with reference to any specific scenario for water uses.

[31] An example of Steps 3 and 4, the appraisal of environmental functions associated with freshwater resources, in the region of Bretagne in Western France, is given by Douguet & Schembri (2000). An example of scenario-based multi-criteria appraisal incorporating stakeholder concertation, for water resource futures in the district of Troina, Sicily, is given by De Marchi et al. (2000).



The deliberation cycle in the "Theatre of Sustainability"

By starting with the social significance axis of learning (Step 1), it is emphasised that the information and appraisal requirements for water resource/environmental governance are grounded in specific contexts of learning and action. These will include both formalised and "informal" knowledge, the latter being typically held by members of local networks and communities (including retailers, financial and agro-business services, etc.) without necessarily being abstracted or theorised into systematic models. Interactive stakeholder-linked approaches imply the need to present and discuss scientific and socio-economic findings to interest groups with a range of different interests, on a permanent (i.e. recursive) basis. It is here that the new interactive ICT can be particularly effective.

PART THREE - ICT IN THE SERVICE OF WATER RESOURCES GOVERNANCE

Exploiting ICT for Framing social choices over water resources

Researchers and teachers all over the world are currently exploring the use of information and communication technologies (ICT) as a medium for organising economic and environmental information so as to respond to qualitatively different educational, analytical and normative circumstances. Multi-media ICT products typically permit individual use (such as from a CD-rom or web-site access). They imply also the user as a member of larger communities. Learning is always a social process with its contexts (geographical, institutional, etc.) where individuals participate in collectivities through various forms of inter-subjective communication. A convivial or user-friendly ICT video interface links a person within their "own place", to other spaces of life, other information forms, interests, interest groups and policy analyses, by corridors of translation and reciprocal appreciation.

Two key forms of computer-based representation can be considered as the stage props helping to bring water governance problems onto the stage in the theatre of sustainability. In the terminology introduced by Guimarães Pereira & O'Connor (1999), these are: (1) Personal Barometers, allowing quantification of environmental impacts of individual lifestyles; and (2) Scenario Generators, allowing individual, firm or household unit activities to be put in the context of possible future trends and changes in patterns of economic activity and in the state of the environmental resources. The two, taken together, consist of a family of models and visual representations that allow the quantification of environmental impacts linked (directly or indirectly) to personal consumption and lifestyle, and also the specification of scenarios developing different perspectives of "what is sustainable" in economic and environmental terms. The governance challenges can be brought into focus by this process of visualisation.[32]

In the schematic figure on the next page, we illustrate the general idea with reference to exploitation of common-pool aquifer resources.[33] At the "local" level individual water uses are quantified. A Personal Barometer that makes a simplified representation of individual household, factory or farm unit water uses, would allow people to evaluate their personal contributions (direct and indirect) to aquifer exploitation, in both systemic and social significance terms. This can then be set, via the Scenario Generator, in the perspective of aggregate water availability and quality issues.

The ICT personal barometer as a (hermeneutic) social science tool

Imagine the sorts of responses and conversations that might eventuate when a farm owner or manager or worker responds to the question, how much water do you use? In the "conversation" mediated by the ICT, various types of answers might be forthcoming and this raises questions about the factual reliability of information supplied and of the purposes of supplying the information. One can make a simple classification, namely, (1)"Don't know", (2)"Deliberate dissimulation", (3)"Telling the truth".

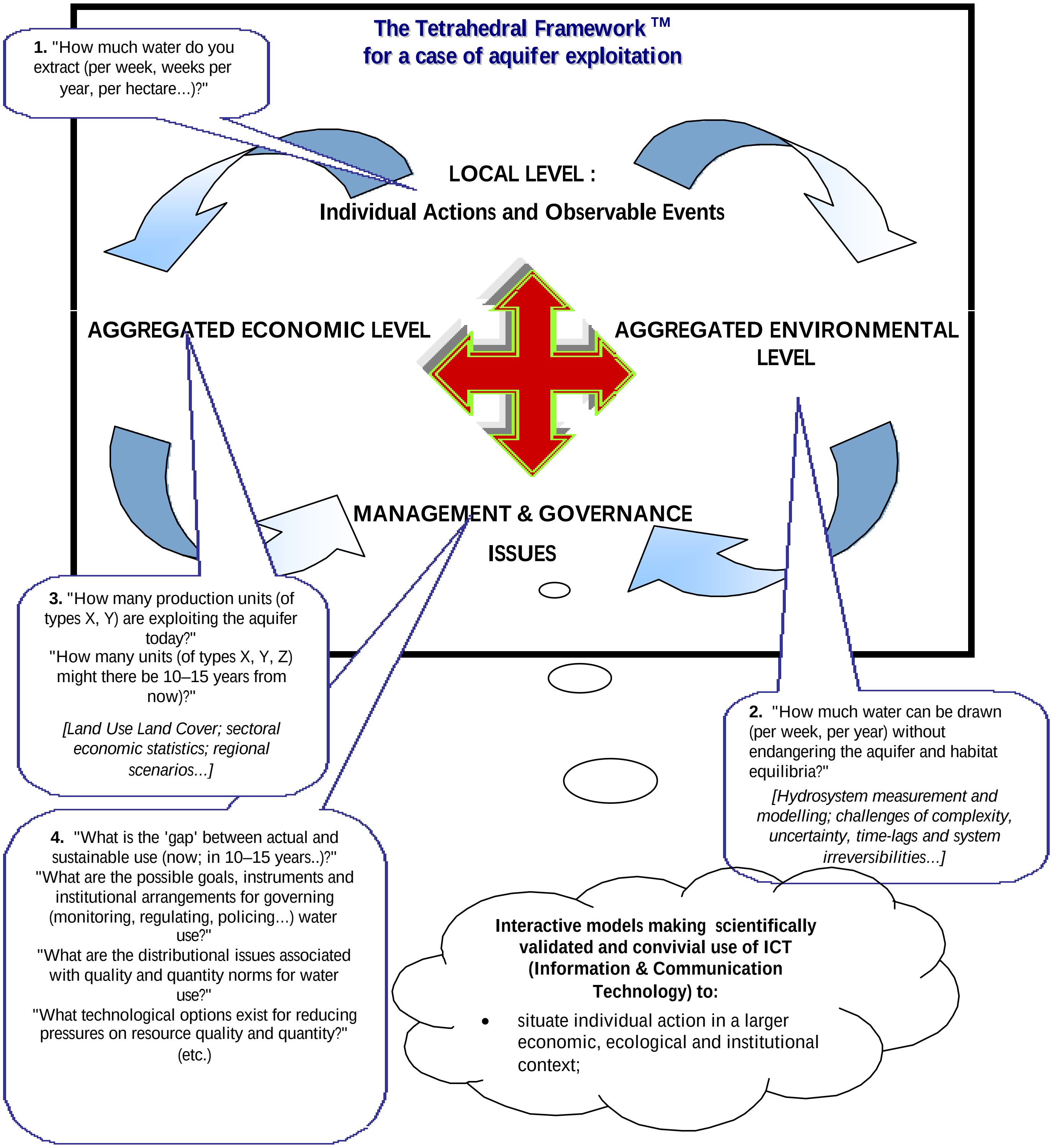
Suppose that the true situation is extraction of 500 m^3 per month (for some crop type and cultivation area). For systems science purposes, it is important to have an idea about the reliability of information. A problem for scientists seeking data to calibrate their models is then to learn something about the status and reliability of the responses. In this regard, emphasis can be placed on the question of the social significance and the motivations that might be underlying the different categories of response. In this case, the interaction or interview process is framed as an intriguing social science situation rather than a frustrating systems data collection situation. And then the learning and exchange of information in this social-science mode can, moreover, become — indirectly — an effective mechanism for model calibration and validation and for evaluation of scientific results.

---

[32] In the **ViRTUALiS** project, we propose that the primary user interfaces should include "local" level of knowledge categories, for example, individual water uses by farmers or households may be quantified. The purpose of a Personal Barometer will be to allow people, interacting with the computer, to specify their personal contributions (direct and indirect) to aquifer exploitation, and to begin to reflect on the wider context of these individual actions in both systemic and social significance terms. In the *GOUVERNe* project, with the multi-media interfaces are oriented towards institutional users, it makes sense to work from the outset with the Scenario Generator, along the lines outlined below.

[33] There is a huge literature on water resources politics (e.g., McCully 1996; Blatter & Ingram, eds., 2001). For two examples on underground resources, see Aguilera-Klink et al. (2000) and Allal & O'Connor 1999 in Lonergan (ed., 1999).

In order to illustrate where this leads, we have invented possible reasons, being combinations of circumstances and motives that might correspond to a response being true, or untrue, in each category of response. These are shown in the Table below.



The suggestions in the Table are quite hypothetical, however they allow two key points to be illustrated. First, responses may, in a variety of ways, be grounded in motives related to economic interests and social relations. Economists will often emphasise strategic considerations about the release or withholding of information and about the falsification of information. Anthropologists might put more emphasis on the implicit negotiation of social relations and status via, e.g., the scale of water use or the efficiency of water use, … Second, if nothing other than the responses are available as data, it is rather difficult to decipher the character of the responses and the factors that might be underlying them.

Information and Dis-information — The Play of Reasons and Interests		
Category of Response (Q. "How much water do you use?)"	**Transparent meaning** (possible explanations)	**Dissimulation** (possible explanations)
"I don't know"	She or he really doesn't know (probably there is no water metering or charging system…)	S/he has a fairly good idea but doesn't want to say (e.g., fears use of the information against her interests, or believes she should be paid to supply information…)
Much higher than the real level	A sincere response based on miscalculation or misperception	A strategic response that constitutes a claim on the water. E.g., a water regulation schemes is being contemplated where property rights may be based on historical usage…
Much lower than is really the case	A sincere response based on miscalculation or misperception	A strategic response that constitutes a social positioning statement. E.g., wants to convey the image of an efficient or frugal use of water (in order to avoid shame?)
Close to the real situation	Knows and tells (e.g., operates pumping technologies that permit monitoring)	S/he is really unsure, but doesn't want to admit this, and just by chance has estimated a figure close to the reality

These examples of method and empirical results, although simplified, are enough to show information not as a quantity, rather as a social process of building and negotiating meanings and capacities of action. In a deliberative approach to the construction and resolution of resource management problems, one may exploit the strategic and social relations factors in order to "build a common problem". ICT interface capacities can be exploited so as to situate water users in relation to the collective problem. The answers that individual water users give, and the reasoning underlying their responses (and their non-responses, their silences, their dissimulation), all convey something about the socio-economic realities and the stakes.

Using *ICT,* branching out from a Personal Barometer, it is possible to set individual water use figures visually (by images, graphs, commentaries) in comparison with figures for local or regional averages. These figures, e.g., amounts of irrigation water for maize in western France, can be presented in comparison to figures for other crop types (such as wheat) and for other countries (e.g., Israel, where water-economising technologies are very advanced). Respondents can also compose their own estimates. For example, an individual farmer's figures can be multiplied up, on the basis of data (or guesses) about the numbers of users in each category, in order to obtain a figure for aquifer exploitation at the whole catchment level. Using the Internet, or printed sources, other information — or guesses — can be brought in, about the full range of water exploitations (including extractions for industrial uses, if any, and town water supply, etc.) and about the aquifer's recharge or carrying capacities. In this way, a process of reflection is created where the individual farm activity is placed within the greater economic and hydrological scheme of things.

Moving forward from these initial phases of building and reconciling pictures of the present situation, explorations can be made of possible — and perhaps desirable — futures. This is where the Scenario Generator concept comes in. Suppose that, according to individual farmers, or fertiliser companies, or the Chamber of Agriculture, production of maize is expected to increase by a factor of 10 over the next 15 years. What will this imply for water demand? The water consequences of economic development scenarios can then be set in confrontation with observations and hypotheses gleaned from hydro-system modellers and farmers' own observations about aquifer storage volumes, recharge and replenishment rates, water table changes, and so on.[34]

Constructing the Future as a Fuzzy Object

Of course, the typical water resources governance problems are not usually as simple as summing up users' data and agricultural sectoral forecasts and setting these in relation to aquifer "carrying capacity". Not only are there many uncertainties but, in addition, there will be much geographical heterogeneity and many different classes of water use including re-use and returning of (dirty) water into catchments.

Therefore any Scenario Generator dedicated for policy applications (rather than purely teaching purposes) must be customised. There are, nonetheless, a certain number of general methodological points that can be made, notably concerning the key notion that what is being sought is a representation of the future as a composite scenario or "fuzzy object". Without being exhaustive, the following considerations that are important for the GOUVERNe project case studies can be taken as steps towards a generic methodology.

First, the formalised representation of different conceivable future states of the world can be made in two distinct modes:

- in a comparative static way;
- or via portrayal of a variety of possible trajectories in continuous time (up to some specified time horizon or simply in the haze of "far away").

Second, an evocation of the "fuzziness" of the future can be developed, within the stylised confines of scenario formalism, in a variety of ways:

A small number (say 3 or 5) of contrasting scenarios whose discrepancies — each one in comparison with the others — make visible dialectically the indeterminacy of the (fuzzy) object.

[34] If this process takes place interactively, then individuals' water use figures, guesses, estimates (and so on) are exposed to reciprocal scrutiny. This brings the possibility, for each *ICT* user, of assessing others' assumptions and of evaluating information claims. People may interrogate each other, in more or less convivial fashion ("I don't believe it", "That's not possible!", "You'll need more water than that..." and so on). The *ICT* users may be led to reflect on, and debate with others, the assumptions made about individual uses — including their own, present and future — and about sectoral developments, aquifer recharge rates, water table and wider ecological consequences (riverside vegetation, fish populations in rivers, and so on). They are led to identify impossibilities and contradictions. These may include seeming systems impossibilities (e.g., how to really extract 5 million m^3 of water annually from an aquifer whose recharge rate is estimated at 2 million ± 50% for an average year...). There may also be social and economic impossibilities, such as where to sell all the maize at a worthwhile price?

A large number of distinct scenarios obtained by taking all, or a subset of, the combinations of futures generated by finite discrete alternatives (say, A1, A2, A3,..., B1, B2, B3,..., etc.) for a finite number of scenario specifiers A, B,....

A continuous "space of possibilities" whose contours and limits are defined by the domains over which the scenario specifiers are permitted to vary.

And so on. Each of these techniques of representation can have advantages, and limitations, when it comes to creating a multimedia "fuzzy future" as a support for interactions in a deliberative process. We mention some of the pros and cons, in order to highlight the different cognitive possibilities that may be opened up by representation options.

The "continuous space of opportunities" format, if programmable for real-time scenario generation, would have the prima facie advantage of allowing the use of "slider" type interfaces [A ranges from A0 ➔ A1], whose values can be selected by the system users on the basis of personal conviction or discussion in groups.

The "large number of scenarios via combination" can be regarded as a discrete variable form of the space-of-possibilities concept, and once again, if programmable for real time scenario generation (or, plausibly, access to pre-calculated data files permitting quick access to the visualisation of the scenario), would permit system users to "define" a preferred scenario or scenarios through setting the choice variables. The discrete combinatorial structure would also be amenable to Monte Carlo type investigation methods, if these are somewhere thought to be variable.

Both of these representation techniques have the merit of allowing the user(s) to specify one or more scenarios as — subjectively — a process of creation or choice (even if, at another remove, the space of possibilities has already been exhaustively characterised). The process of scenario choice/creation can be the occasion for judgements, commentaries, opinions and arguments can be expressed, notably about which states of the future world or trajectories are plausible or desirable (or not) and why (or why not).

Moreover, these techniques readily permit the selection, through individual or group processes of experimentation and choice, of a "small number of contrasting scenarios", thus obtaining this latter representation mode as a derivative of some variant of the former. However, two limitations to this line of approach must be pointed out.

First, the sheer computational/processing demands of this procedure (which depend on the complexity and data needs of the underlying models as well as of the visualisation techniques being employed) may render it impracticable, especially as the number of combinations is increased towards the "continuous space of opportunities" version.

Second, and quite apart from the computational constraint (which must be evaluated case by case), there can be some drawbacks in the way that the users are, in the "scenario selection process", strictly confined in advance to the terms in which the "degrees of freedom" for the fuzzy object are framed within the underlying model.

It may be proposed that the representation from the outset in terms of a "small number of qualitatively contrasting scenarios" is even more restrictive in this regard. However the situation is not quite so straightforward. A feature of the "small number of scenarios" approach is that the way that each scenario might be characterised need not be restricted to choices in algebraic form (that is, choosing between discrete alternatives or selecting a value on a scale, etc.). In the "small number of scenarios" approach the scenarios can be created/concocted sui generis in a narrative mode (which, as will be discussed below, must only at a later step in the analysis be translated into model specifications and, at this point, submitted to the straitjacket of "parameterisation" with discrete or continuous formats permitting "criteria" to be defined).

The narrative mode permits, in principle, a rich texture of social meanings to be evoked — the indeterminacy of connotations, contexts and interpretation over and above the algebraic "fuzzy" forms.

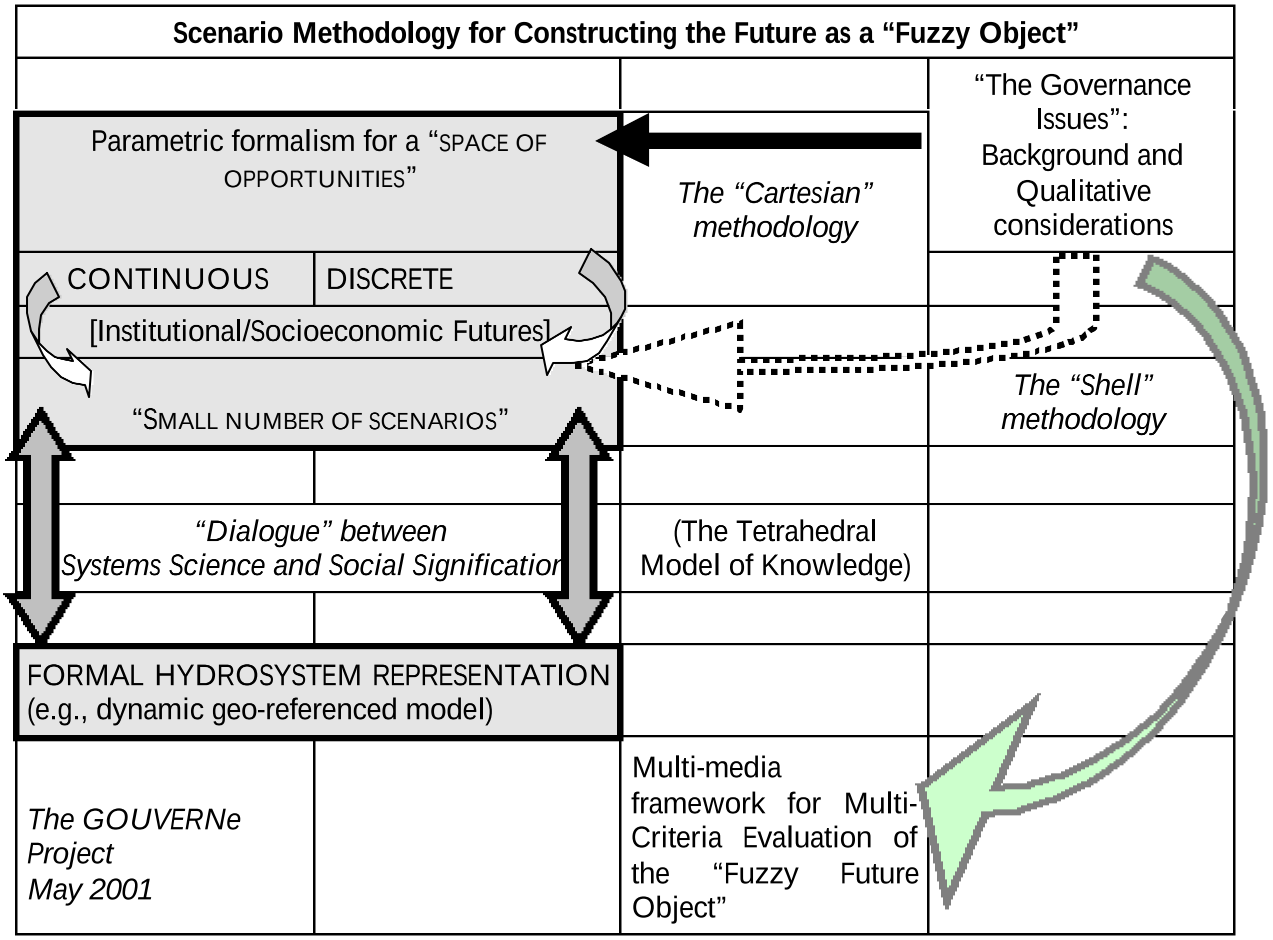
Because the "small number of narratives" are priorly specified, the focus for a person or group of persons working with the set is not on specifying a scenario;[35] rather it is on appraisal of what is attractive or unattractive (etc.) about each of the scenarios considered in relation to the others. Moreover, it may be hoped — that is, hypothesised within the scientific process — that through the juxtapositioning of several different scenario images that have each a qualitatively different character (we will refer to the "profile" or the "personality" of each scenario), there may arise a more "organic" process of evaluation by participants. Rather than being preoccupied by the questions of choosing the settings or parametric specifications that will generate a scenario, the user is (or, the users are) observing and reacting to scenario images that — as a composite of distinct images juxtaposed— have a complex and multi-faceted character. The "denotation" of each scenario (viz., the parameter settings, etc.) is not immediately dominant, and the observer/users may attribute "connotations" to one scenario in relation to others or in relation to their (the users') own preoccupations.

Of course, being confronted with a "composite" in this way does not prevent a participant from expressing a straightforward preference for one scenario over another, on the basis of some criterion of (for instance) economic interest or moral or political commitment, indeed on the basis of a visible indicator used to characterise each scenario (such as water contamination levels, or price of access to water). However, the hypothesis is that, when confronted with the "composite" of several images that have "profiles" that contrast along many different lines, a participant (or a group of participants) may spontaneously perceive the "problem of multiple criteria" and, related to this, the way that judgements will depend on a wide variety of elements including personal make-up, cultural frames of reference, political convictions and notions of economic rights and wrongs.

This recognition — spontaneous or induced by elements of the multi-media representation — then becomes the point of entry for operating a "formal (that is, explicit and structured) process of scenario evaluation.[36]

[35] This does not exclude the possibility that, at another remove, the stakeholders or "users" might participate (or, indeed, might already have participated) in the creation of some or all of the scenarios being portrayed. The point is that, in this procedure, the "small number of scenarios" are not being specified in real time.

[36] Steps and design concepts for the multi-criteria evaluation are the object of current work (late 2001) in the *GOUVERNe* project. What is important, once again, to note is that the "formal" structured evaluation procedure is embedded inside an informal social interactive process. So there will always be two outcomes of such a process, first the results of the explicit and instrumental evaluation procedure, and second the "experience" of this procedure and of the results for those participating (as can be documented by a variety of qualitative social science methods or by the participants themselves...) Two research studies that provide useful further indications on these matters are (1) the Troina water use futures multi-criteria study carried out within the VALSE project (De Marchi, et al., 2000) ; and (2) the documentation by participants themselves of experiences within focus groups in the Venice ULYSSES and VISIONS projects (see De Marchi et al., 1998 and the ULYSSES and VISIONS multimedia presentations on the website http://alba.jrc.it/).



It is, of course, quite possible to combine the "space of opportunities" framework with the "small number of scenarios" format. Where, in the first instance, a large "space of opportunities" can be specified, a stakeholder participation could be developed leading to the selection of a (small) finite number of discrete scenario paths/propositions. This group of scenarios, whose profile(s) already reflect(s) the users' reasons, judgements and priorities (etc.), could then be adopted as the "fuzzy object" for subsequent rounds of stakeholder deliberation. (At this point, the same participants could be implicated, or different users could be brought into the process.)

This staged procedure, while intellectually having some appeal, may lead to complications. Leaving aside the computational or visualisation requirements that may constrain a process of real-time scenario specification (as discussed above) there may also be difficulties with the preparation — in advance or in real-time! — of a well-adapted multi-criteria framework for the interactive evaluation of scenarios whose profile is not known in advance.

This remark takes us back to the underlying methodological issue of how to manage the interplay of "open" and "closed" procedures, and of "formalised" and "informal" aspects of representation and communication. We present a schematic overview of the methodology in the Table above. This helps to highlight that stakeholder participation in the research leading to the elaboration of the fuzzy future can already take place at several points. First, in the identification of "the Governance Issues" (upper right corner). Second, in the case that "the Shell Methodology" of participatory brainstorming is used for generating scenario profiles. Third, in the case that stakeholder participation is a procedure for selecting a small number of scenarios from a larger space of opportunities (curved arrows in upper left hand grey box). There can also be stakeholder participation dimensions in the elaboration of the multi-criteria framework. Once the "fuzzy object" is created, of course, the question is whether or not it will be effective in its desired role, as a support for concerted stakeholder deliberation...

Elaborating Governance Issues as attributes of a fuzzy future

Suppose that the governance problem is an "over-use" of fresh water, which may mean river flow reduction, aquifer drawdown and aggravation of water quality problems. One management response for the quantity side of the problem could be to install a comprehensive water metering system and operate water rationing based on allocation of quantitative access rights. Obviously, in the absence of strong policing and/or strong attitudes of co-operation, there could be strong self-interest incentives to tamper with the meters, or to obtain special tariff and access arrangements via back-room deals (which are not necessarily overt bribes), etc. The classic Prisoners' Dilemma is reconstructed, but not resolved.

Rather than impose a management solution externally, we can envisage concerted stakeholder deliberation as a process for evaluating and, eventually, choosing among alternatives. For a concertation approach, we seek to allow water users and other stakeholder groups, each with their various social, ecological and economic contexts, to situate themselves in relation to visions of possible — and perhaps desirable — futures. This is where the **Scenario Generator** comes in. Individuals and groups who are engaged in the construction, or evaluation, of scenarios of feasible (or infeasible!) futures, may be led to situate their own actions and motivations within the wider scene. They may reflect on and debate the assumptions made about individual uses — including their own, present and future — and about sectoral developments, aquifer recharge rates, river flows, water table and wider ecological consequences (fish populations in rivers, and so on). The scenario representations of feasibility and infeasibility thus become the supporting framework for discussions and debates about what might be desirable and for whom.

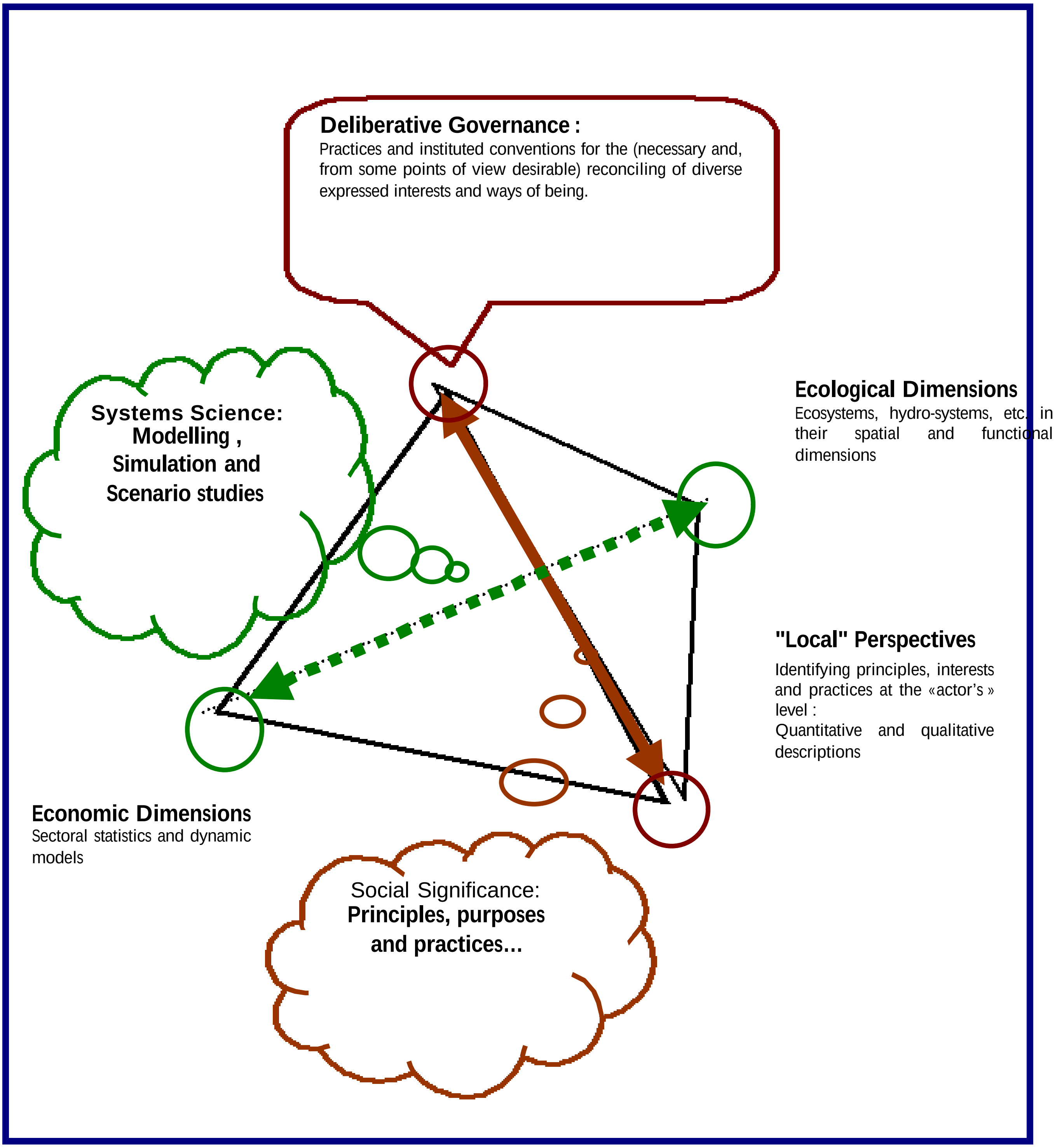
In the GOUVERNe project, we have decided that, for maximum pertinence to stakeholders, the identification of governance issues should be made the departure point for the development of any set of scenarios.[37] Our approach is thus based on bringing together analyses from the two grand dimensions of the social choice problem outlined in Part I — systems science and social signification. This "integrative" approach may be thought of as a sort of conversation. In the analysis phases we allow a certain "autonomy" to each dimension but also insist on building procedures so that each one is constrained or disciplined into making "cross-references" to the other. In effect, what we seek is to develop a "dialogical" method of inter-disciplinary work, with all the aspects present of learning, internal rigour, judgement, interpretation, communication. In brief,

- SYSTEMS SCIENCE portrays the contributions, and potential contributions, of the water resource in terms of "Environmental functions" — that is, the capacities and performances of natural processes and components which satisfy human needs.
- SOCIAL SIGNIFICANCE as revealed by the Justification Forms that people advocate for Resolving perceived Governance Issues, viz., in what terms are these "governance issues" portrayed and judged by the actors concerned (categories of interests, political principles, ethical outlooks, collective identity (etc.),

The Tetrahedral Model™ (below) is a simple schema for portraying the various sorts of knowledge that must be brought together in this integrative analysis for water resources

[37] The epistemology of the future as a fuzzy object is complex (and itself rather fuzzy!). From a social science point of view, there are many reasons for this choice; however a major one in the present context is that it seems the best adapted to obtain forms of representation that have ready "accessibility" for various stakeholder interests.

governance. The Tetrahedron is composed with two complementary (skew) axes that portray, respectively, the "feasibility" and "desirability" aspects of social choice.



Governance issues may be framed as responses to the question, What are the main types of conflict or contestation over "access to scarce environmental functions?" The scenarios that make up the Fuzzy Future then portray different prospects for the "working out" through time of governance issues characterised as conflicts for the appropriation (physically, juridically or ideologically) of scarce environmental services and functions.

Examples from the GOUVERNe Case Studies

The GOUVERNe Project is ongoing, so it is possible only to report work in progress. We will use two of the four case studies to furnish examples of the way that governance issues have been identified and incorporated into scenario storylines.

First, we mention work carried out in the CHAMPIGNY case study — for a major rain-fed aquifer district in the greater Paris region that serves rural as well as metropolitan uses and that is diffusely vulnerable to chemical contamination and to quantitative depletion. A qualitative institutional analysis and stakeholder mapping has been carried out which identified six distinct governance issues/axes, as follows (Amorsi 2001):[38]

A. Competition for privilege in conditions of access defined in terms of PRICE and QUANTITY (economic distribution), e.g. industry players that seek direct pumping rights;

B. Quality degradation (pesticides, nitrates, industrial pollutants…) ➔ "SEGREGATION" of user categories in terms of QUALITY requirements, e.g. (1) farming and industry is not as exigent as potable water supply to local collectivities; (b) differentiation between Paris for potable water and rural districts "supplying" this water while losing control over the resource;

C. Differentiation within rural Champigny between that have their own high quality water, and those districts that have polluted water and cannot supply their own, is not only a quantity/Quality segregation, it also plays at the level of IDENTITY, perhaps of STATUS, linked to collective identity and to notions of patrimony, local economic security and autonomy;

D. "QUALITY OF THE ECOSYSTEM" — A "weak signal" that intensive extraction plus contamination of the aquifer may lead to water table, water quality and hence ecological changes that will affect various "recreational" uses/users;

E. POLITICAL PROCESS — rapport de force and mode de décision: will resource governance take place via stakeholder concertation vs. enlightened despot vs. capture by dominant interests? Which interests will dominate water quality and distribution issues (agriculture sector, local municipalities, Paris metropolitan needs, the water distribution companies...)?

F. DEGREE OF ARTIFICIALISATION — the extent to which piped, recycled and technically purified water replaces local source supply for communes and industry, defines the status of water as a natural/cultivated/produced capital.

These six categories seem fairly generic, suggesting that the typology could have wide applicability for European water studies.[39] Having identified governance issues for the case study in question, it is then necessary to propose how these may come to be reflected in individual scenarios and, thus, in the Fuzzy Future as a "composite" of the scenarios. This step will not have a unique method for response, partly because the complexity of the issues and their geographical heterogeneity can differ greatly from case to case. Generally speaking, it is

[38] These six categories are not exclusive. For example, A, B and C clearly all interact; and . It can be discussed if the "degree of artificialisation" (item F) is best treated as a separate axis, or a part of the others.

[39] The typology was established systematically for the Champigny study and is corroborated by the types of governance issues identified independently in the other case studies (see Rinaudo et al., 2002 for the BRGM's Hérault study; and Blatsou 2001 for the Argolid case study). However, before proposing hasty transposition for all and sundry European water studies, we allow that further reflection and comparison between the *GOUVERNe* case studies may lead to revised specification or to further distinct categories.

necessary to identify how key decision items (either goals or actions) and trends of change — that may variously be judged good or bad or otherwise — will show up in the scenario specifications (parameters and/or explanatory narratives).[40] These are the tendencies, events, actions and outcomes that, portrayed through the ICT to stakeholders, are the attributes for comment and appraisal.[41]

In line with the options of the scenario methodology schema presented above, there are several possible modalities for the identification of key actions, policies and "decision items" (etc.). Two main alternatives are the following:[42]

- Following the "Cartesian methodology", the scenario profiles can be determined in terms of key water policy or management decisions that are immediately reflected in the parameters and "settings" of a formal hydrosystem/water use model. In this case there exists by construction a clear correspondence between the terms in which the scenarios are described on the socio-economic/governance side, and the terms in which the scenarios are represented on the hydrosystem/geographical and economic (water uses) side. This is the approach adopted by the BRGM for the HERAULT case study, in which socio-economic analyses and hydrosystem/water use model construction have been carried out with close reciprocal communication.[43]
- Following the "Shell methodology", the scenario profiles can be elaborated through a "brainstorming" process involving researchers and, depending on circumstances, a variety of stakeholders, who set out to specify a sequence and/or concatenation of elements (actions, policy choices, consequences, etc.) that come to comprise an emerging future. This procedure does not depend on explicit reference to a hydrosystem model, but constructs one side of a potential dialogue if such a modelling analysis exists or can be separately carried out (see below). This is the approach adopted by the C3ED in collaboration with the Conseil régional Ile de France (a GOUVERNe Project partner) for the CHAMPIGNY case study.[44]

For the Hérault case study, for a hydrosystem in the south of France with closely coupled river and aquifer sub-systems, the BRGM team applying the "Cartesian methodology" has identified a small number (four) of major "scenario drivers" that are seen as likely to shape the future status of the water resources and their uses. Then, for each scenario driver, a small number (typically two or three) of contrasted discrete alternatives are identified and described, on the basis of stakeholders' and researchers' perceptions of plausible actions, policy choices and system evolutions (Rinaudo, et al., 2001). These alternatives (actions and/or outcomes) in the context of the over-arching set of "drivers", represent the governance issues. The four major "drivers" are:

[40] We also note, but do not develop the point here, that the typology of governance issues is important for orienting how geographical information (GIS-based) may be used for the visualisations. This is the case, first of all, with spatial visualisation whenever the "issues" are distributed ; and it is also true for choices about the geo-referencing of selected categories of economic information (e.g., land uses or economic sectors of activity, in relation to water price/access conditions...), or quality for drinking of local water sources; networks of transportation of drinking water (and change through time), etc.

[41] The evaluation criteria may, in principle, be either offered to, or furnished by, the stakeholders in the context of their appraisal of the scenarios.

[42] We give here, as illustrations, the work on the CHAMPIGNY and HERAULT case studies. For the ARGOLID and PROVINCE OF MILAN case studies, the formal scenario profiling exercise has not yet been carried out.

[43] See notably the three working documents: *Confrontation du point de vue des acteurs sur les usages de l'eau dans la moyenne vallée de l'Hérault* (BRGM/RP-50716-FR, Montpellier, February 2001); *Modèle socio-hydrologique global de la moyenne vallée de l'Hérault* (BRGM/RP-50872-FR, Montpellier, April 2001); and *Plaine d'Hérault: identification de l'hydrosystème et évaluation du rôle socio-économique de la ressource en eau* (BRGM/RP-50882-FR, Montpellier, May 2001).

[44] A detailed exposition of the methods and procedures adopted, and the first round of scenario profile results, is contained in an unpublished Working Document by N. Amorsi & M. O'Connor: "Profils du Futur Champigny" (C3ED, June 2001).

- Intensified urbanisation that may lead to increased domestic and industrial water demand;
- Regulatory pressures on agriculture that is a heavy water user for irrigation;
- The potential exploitation of the karst aquifer as a drinking water supply for the city of Montpellier and/or other municipalities in the district, with potentially major impacts on the water table, on natural springs and on the Hérault river flows;
- Climate change which, speculatively, may lead to reduced rainfall (or to greater variability in rainfall from year to year) and hence reduced aquifer recharge and discharges in rivers.

The Climate change issue has been included largely in response to some local stakeholders who are strongly convinced that, already over the past decade, there is discernible climate change. However, quantification of such effects is highly speculative, and so the scenario alternative specifications are kept very simple: "as usual" or "frequent dry year". For each of the other three issues, a "high", a "medium" and a "low" trajectory has been described. This means logically that there are 3x3x3x2 = 54 combinations of the possibilities offered.[45]

Work is currently being carried out by the BRGM and other GOUVERNe project partners, to develop a multi-media decision support system, including a geographically distributed representation of the water resources and their uses, that will allow a user to construct his/her own scenario by a choice of any combination of the "drivers". Then, the use(s)r may evaluate the scenario selected, using a variety of criteria that have been developed on the basis of prior discussions with different stakeholders.[46] By a process of comparison, discussion and deliberation, perspectives can be shared about the consequences of key water management decisions and the wisdom or justifications for different options.

The C3ED's work on the Champigny aquifer, in association with the Conseil Régional Ile de France, has adopted the "Shell Methodology" based on the construction of contrasting scenarios at a "narrative" level. This method has the advantage of permitting a relatively "free" interplay of researchers' and stakeholders' perceptions (and this is indeed the reason it is often used in exploratory scenario studies as a way of framing contrasting perspectives). After extensive consultation with stakeholders, analysis and documentation, an exercise was undertaken of "composing" scenarios through a "free association" of propositions of actions and outcomes from the spectrum of elements available from the analysis. The result was a group of five qualitatively distinct scenario narratives, which have received provisionally the following designations:

- "Restoration of Consumers' Confidence" — after a crisis with falling water quality due to agricultural and other pollutions, there is successful concerted action involving water users, municipalities and farmers themselves to assure high water quality.
- "Towards Institutional Coherence" — there is a successful mobilisation of political/economic actors at the local and district levels so that the aquifer quality is "taken in hand". Labelling schemes help the viability and visibility of low-(chemical agriculture techniques
- "Individualist Tendencies" — a sort of generalised Prisoners' dilemma. Although the various interest groups are not disdainful of the issues of water quality, they do not manage to transcend the preoccupations of their individual interests to reach a common ground. Overall the aquifer water quality deteriorates and solutions to perceived water quality problems are patchwork.
- "Abandonment of the aquifer" — there is not sufficient attention to risks of diffuse pollution and, progressively, local access to water is closed off (due to contamination) to the point that

---

45 If some of the scenario drivers are correlated (meaning that not all combinations are permissible), then the number of scenarios "on offer" is correspondingly reduced.

46 The main interest groups include: the Canal Irrigation Association (representing farmers' water interests) and individual farmers (often having autonomous wells); various municipalities including local towns and also the larger city of Montpellier; households/householders living in the districts served or potentially served by the aquifer water; recreational users (for swimming, fishing, canoeing, etc.); fishermen and fishing associations; and environmental groups (representing landscape, ecosystem and biodiversity interests...).

after some decades the aquifer is forgotten as a former major source of high quality drinking water.
- "The Water Companies' World" — stakeholders develop an awareness of water scarcity and pollution risks but prefer to wait for technology solutions. This leaves the playing field open to the efforts of the major water distribution companies who seek to manage the playing field, e.g., alliances with farmers to protect sensitive source zones, different water quality and cost requirements for different user groups...

These scenarios are yet to be submitted to stakeholders (notably through an Association made up of various user representatives, etc.) to ascertain their plausibility. A further round of scenario composition is envisaged, that will directly involve some stakeholders in the exercise. Whatever will be the final scenario profiles retained, it is anyway necessary that the outcomes of such an exercise also be submitted to the "discipline" of available hydrosystems and economic knowledge (e.g., spatial distribution of land uses and of economic activities generally; current and postulated future volumes of water use, etc.). In the case of the Champigny, this "discipline" will be imposed through interfacing the provisional scenario narratives with an independently existing hydrosystem and land use/water use model (work undertaken by other parties, not within the GOUVERNe project itself).

In effect, the request will be made to the modellers to contemplate the "implementation" of the selected narrative scenarios. In the process of responding to this request,

- first, it will be necessary to translate the narratives into terms that the formal representation can accommodate (and this may undoubtedly require some significant straitjacketing);
- second, the narrative is "tested" for plausibility and coherence from the point of view of the "formal" representation and the knowledge that this latter embodies (and, it may be that significant reformulation of the narrative scenario profiles will be forthcoming).

The definitive construction of the Fuzzy Future Object for the Champigny case study will be the outcome of this procedure. Frameworks permitting the evaluation of the scenario outcomes are currently under development.[47]

Concluding Remarks

The above pages are a sketch of aspects of work in progress. What is important is that the role played by the ICT is not simply to "convey" information. Rather it is to support the inter-subjective process by which knowledge and meaning are created and shared, that is, made to emerge in a "public forum" so that deliberation by stakeholders as members of a society accountable to each other becomes possible.

Of course, this perspective on concertation will not be shared by everybody and there may well be categories of water users or decision-makers who prefer to hold onto existing power and privilege. Yet, inasmuch as the ICT representations can facilitate a learning and sharing of perspectives, the process of common problem representation can be the point of departure for a deliberative search for sustainable use solutions based on restraint, respect of divergent criteria and the acceptance of a principle of coexistence.

[47] This paper, pitched at a methodological level with emphasis on the role of the scenario concepts, has not addressed detailed operational, stylistic and empirical questions of the multi-media representation, e.g., whether local-scale indicators such as the existence or closure of a commune's local water source should be portrayed in cartoon formats or in more traditional scientific formats...

References

Aguilera Klink, F., E. Perez Moriana and J. Sanchez Garcia,“The Social Construction of Scarcity: the case of Water in Tenerife (Canary Islands)”, Ecological Economics, 34, (2000) 233–246.

Allal, S. & M. O’Connor, "Water Resource Distribution and Security in the Jordan-Israël-Palestinian Peace Process", (1999) 109–129 in S.C. Lonergan (ed., 1999), Environmental Change, Adaptation, and Security, Kluwer, Dordrecht.

Amorsi, Natacha, Les Enjeux de Gouvernance pour la Nappe des Calcaires de Champigny, C3ED Document de Travail No.2001/02, Université de Versailles st-Quentin-en-Yvelines, Guyancourt, 2001.

Arnoux, R., R. Dawson & M. O'Connor, "The Logics of Death and Sacrifice in the Resource Management Law Reforms of Aotearoa/New Zealand," Journal of Economic Issues, 27, (1993) 1059-1096.

Arrow, Kenneth, Individual Values and Social Choice, Wiley, New York, 2nd Edition (1963)

Blatter, J. & H. Ingram, Reflections on Water: New Approaches to Transboundary Conflicts and Cooperation, MIT Press, Boston (eds., 2001)

Blatsou, Condynelia, “Analysis of water exploitation and governance issues in the Argolid region of Southern Greece”, Annex 2 of the Cranfield University’s Year 1 Report for the GOUVERNe Project (ed., Paul Jeffrey), School of Water Sciences, Cranfield University, March 2001.

Bromley, Daniel W., Economic Interests and Institutions: The conceptual foundations of public policy, Basil Blackwell, Oxford (1989)

Commons, John R. (1934), Institutional Economics: Its place in Political Economy, reprinted (1961), University of Wisconsin Press, Madison.

De Marchi, B., S. Funtowicz, S. Lo Cascio & G. Mmuda,“Combining Participative and Institutional Approaches with Multicriteria Evaluation. An Empirical Study for Water Issues in Troina, Sicily”, Ecological Economics, 34, (2000) 267–282.

Douguet, J.-M., M. O'Connor, P. Girardin, "Validation socio-économique des indicateurs agro-environnementaux", C3ED Rapport de Recherche, November 1999, final report for a study financed by the Programme Inter-disciplinaire de Recherche "Environnement, Vie et Société" du CNRS, France (1999)

Douguet, J.-M. & Schembri, P., CNC: Quantification et Modélisation du Capital Naturel Critique pour la mise en œuvre d'une politique du développement durable en France, C3ED Rapport de Recherche, February 2000, Université de Versailles St-Quentin-en-Yvelines, Guyancourt, France (2000)

Dryzek, John, "Ecology and Discursive Democracy: Beyond Liberal Capitalism and the Administrative state", pp.176-197 in M. O'Connor (ed., 1994), Is Capitalism Sustainable? Political Economy and the Politics of Ecology, The Guilford Press, New York (1994)

Ekins, P. & S. Simon, "The Sustainability Gap: a practical indicator of sustainability in the framework of the national accounts", International Journal of Sustainable Development, 2(1), (1999) 32–58.

Faucheux, S. & M. O'Connor (eds), Valuation for Sustainable Development : Methods and Policy Indicators, Edward Elgar, Cheltenham (1998)

Faucheux, S. & O’Connor, M., “Natural Capital, The Greened National Product and the Monetization Frontier”, pp.225-274 in E. van Ierland, J. van der Straaten & H. Vollebergh (eds., 2001), Economic Growth and Valuation of the Environment, Edward Elgar, Cheltenham.

Funtowicz, S.O. & O'Connor, M., "The Passage from Entropy to Thermodynamic Indeterminacy: A Social and Science Epistemology for Sustainability", (1999) p.p.257-286 in: K. Mayumi & J. Gowdy (eds., 1999), Bioeconomics and Sustainability: Essays in Honour of Nicholas Georgescu-Roegen, Edward Elgar, Cheltenham.

Guimarães Pereira, A. & O'Connor M., "Information and Communication Technology and the Popular Appropriation of Sustainability Problems", International Journal of Sustainable Development, 2(3), (1999) 411–424.

Habermas, Jürgen, Communication and the Evolution of Society, English translation, Heinemann, London (1979)

Hailwood, Simon, "The Value of Nature's Otherness", Environmental Values, 9(3), (2000) 353–372.

Holland, Alan "The Foundations of Environmental Decision-making", International Journal of Environment and Pollution, 7, (1997) 483–496.

Hueting, Roefie, New Scarcity and Economic Growth: More Welfare through Less Production?, North-Holland, Amsterdam (1980)

Kapp, K. William, "In Defense of Institutional Economics", Swedish Journal of Economics LXX(1): 1–18; reprinted (1968).149–167 in: K.W. KAPP (1974), Environmental Policies and Development Planning in Contemporary China and Other Essays, Mouton/Maison des Sciences de l'Homme, Paris and The Hague.

Kapp, K. William, "On the Nature and Significance of Social Costs," Kyklos, 22, (1969) 334–347.

Latouche, Serge, Le Procès de la Science Sociale, Anthropos, Paris (1984)

Latouche, Serge, L'Occidentalisation du Monde: essai sur la signification, la portée et les limites de l'uniformisation planétaire, La Découverte, Paris. English translation: The Westernisation of the World, Polity Press, London (1989)

Lonergan, S.C., Environmental Change, Adaptation, and Security, Kluwer, Dordrecht (ed., 1999)

Martinez-Alier, J. & O'Connor, M., "Distributional Issues in Ecological Economics", (1996) pp.153–184 in R. Costanza, O. Segura and J. Martinez-Alier (eds 1996), Getting Down to Earth: Practical applications of ecological economics, Washington D.C.: Island Press.

McCully, Patrick, Silenced Rivers: The Ecology and Politics of Large Dams, Zed Books, London (1996)

O'Connor, Martin, "Valuing Fish in Aotearoa: The Treaty, the Market and the Intrinsic Value of the Trout," Environmental Values, 3, (1994) 245–265.

O'Connor, Martin, "La Réciprocité Introuvable: L'utilitarisme de John Stuart Mill et la recherche d'une éthique pour la soutenabilité," Economie Appliquée, XLVIII No.2, (1995) 271-304.

O'Connor, Martin, "J.S. Mill's Utilitarianism and the Social Ethics of Sustainable Development", The European Journal of the History of Economic Thought, 4(3), (1997) 478–506.

O'Connor, Martin, "Dialogue and Debate in a Post-Normal Practice of Science: A Reflection", Futures, 31, (1999a) 671–687.

O'Connor, Martin, "Mana, Magic and (post-)Modernity : Dissenting futures in Aotearoa", Futures 31, (1999b) 171-190.

O'Connor, Martin, "Pathways for Environmental Valuation: A Walk in the (Hanging) Gardens of Babylon", Ecological Economics, 34, (2000) 175–194.

O’Connor, Martin, "Social Costs and Sustainability", in Daniel W. Bromley & Jouni Paavoli (eds., 2001), Economics, Ethics and Environmental Policy : Contested Choices, Edward Elgar, Cheltenham (2001)

O'Connor, M. & Martinez-Alier, J., "Ecological Distribution and Distributed Sustainability", (1998) 33–56 in: S. Faucheux, M. O'Connor & J. van der Straaten (eds., 1998), Sustainable Development: Concepts, Rationalities and Strategies, Kluwer, Dordrecht/Boston/London.

Rinaudo, Jean-Daniel, Vincent Petit, François Giraud & Nathalie Courtois (2001), A Methodology to Explore Alternative Water Management Scenarios : Example from the middle Hérault valley, BRGM, Montpellier, Report RP-51083-FR, September 2001.

Rittel, H., "Systems Analysis of the "First and Second Generations", (1982) 153–184 in: P. Laconte, J. Gibson & A. Rapoport (eds., 1982), Human and Energy Factors in Urban Planning, NATO Advanced Study Institutes Series, Martinus Nijhoff, The Hague.

Sagoff, Mark, "Aggregation and Deliberation in valuing environmental goods: a look beyond contingent pricing", Ecological Economics, 24, (1998) 193–213.

Salleh, Ariel, Feminism as Politics: nature, Marx and the post-modern, Zed Books, London (1997)

Samuels, Warren J., "Welfare economics, Power, and Property", (1972) 61–148 in: G. Wunderlich & W.L. Gibson (eds.) Perspectives of Property, Institute for Research on Land and Water Resources, Pennsylvania University. Reprinted pp.9–75 in: W.A. Samuels & A.A. Schmid (eds., 1981), Law and Economics: An Institutional Perspective, Martinus Nijhoff, Boston.

Samuels, W.J. & Schmid, A.A., Law and Economics: An Institutional Perspective, Martinus Nijhoff, Boston (eds., 1981)

Samuels, Warren J., Essays on the Economic Role of Government: Vol.I Fundamentals; Vol.II Applications, Macmillan, London (1992)

Schmid, Allan A., Property, Power and Public Choice, Praeger, New York (1978)

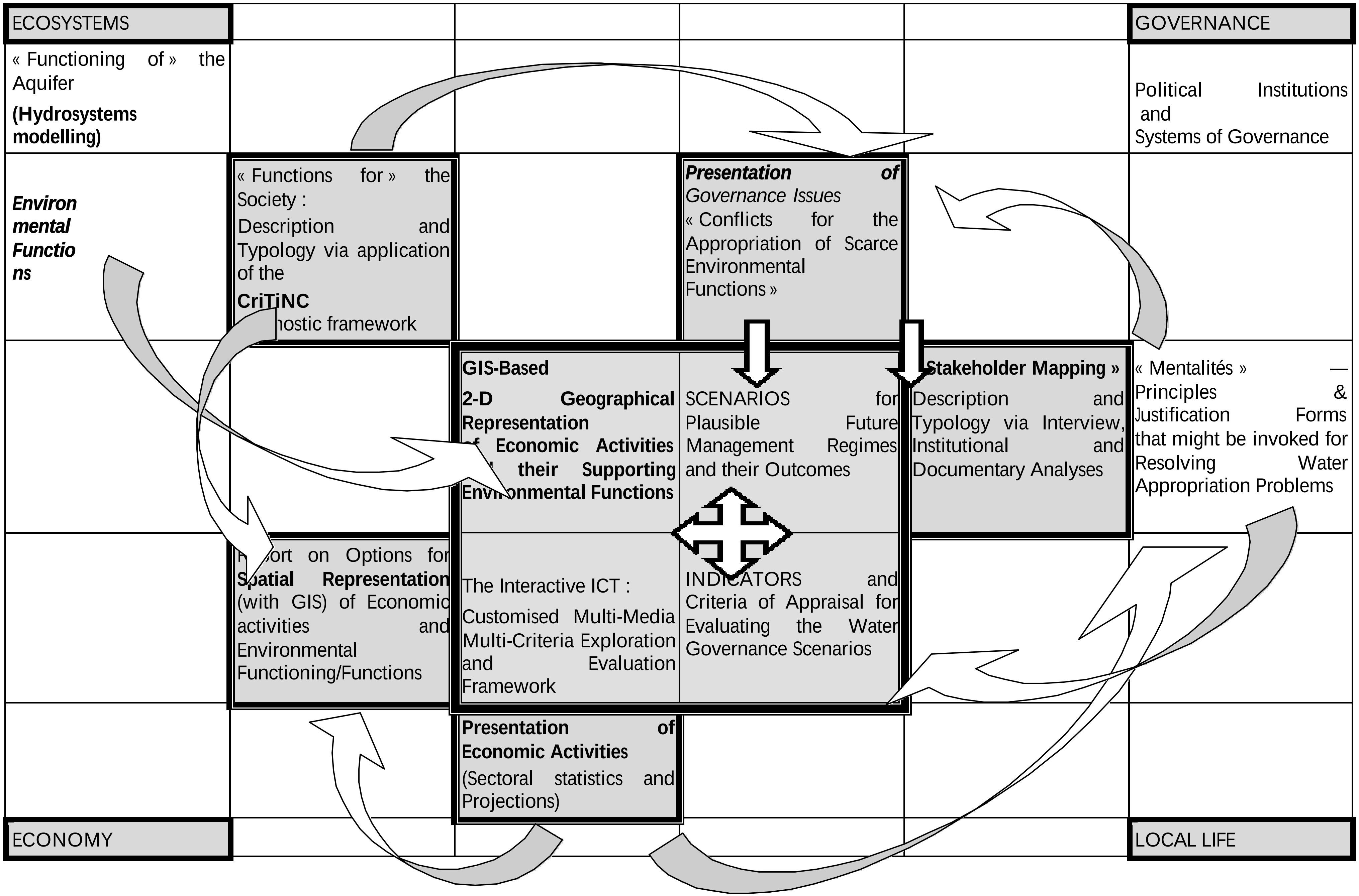
Sen, Amartya, "The Impossibility of a Paretian Liberal", Journal of Political Economy, 78, (1970) 152–157.

Sen, Amartya, On Ethics and Economics, Basil Blackwell, Oxford (1987)

Stone, Christopher D., Earth and Other Ethics: The case for moral pluralism, Harper & Row, New York (1987)

WCED (World Commission on Environment and Development 1987), Our Common Future (The Brundtland Report), Oxford University Press, Oxford.

The figure below gives an overview of the components of the GOUVERNe research process, aimed at producing empirically calibrated and user friendly multi-media decision support tools for concertative governance processes.



Problems and options in assessing Sustainable Development – The SQM approach and experiences in the context of structural funds

Ruggero Schleicher-Tappeser

EURES Institute, Basler Str. 19,
D-79100 Freiburg, Germany
r.schleicher@eures.de
www.sqm-praxis.net

The challenge of sustainable development

Since the Amsterdam Treaty of 1997, the European Union has required that all policies and programmes funded by the EU be conceived and implemented in accordance with to the principles of Sustainable Development. The regulations for the new generation of the European Structural Funds (1999) and more recently the EU Strategy for Sustainable Development decided at the Gothenburg Council (2001) have confirmed this commitment. However, until now, operational tools that allow the assessment of the fulfilment of this commitment are largely lacking.

The reasons for this deficiency are to be found in the essence of the fundamental concept of Sustainable Development. It is an idea that has been publicly discussed for less than two decades. Sustainable Development is not only a new concept, it is a new paradigm, and it requires viewing many things from a new perspective. To understand what that implies takes time and meets with resistance.

Since the Rio Conference in 1992, the call for Sustainable Development has led to many disputes about its interpretation. The growing consensus, which emerges meanwhile from these discussions, is that Sustainability is a general idea, a "regulative idea" in the Kantian sense, as are, for example, beauty, freedom or health (Homann 1996). It cannot be assessed or achieved by simple rules, it needs interpretation in a specific context.

The concept of Sustainable Development was invented because of the obvious shortcomings of conventional development approaches. It presents two basic challenges:

- Whereas the extraordinary development of technology, industry and large organisations of the modern age were strongly based on an increasingly sophisticated differentiation and specialisation, the concept of sustainable development stresses the necessity of an *integrated consideration of different dimensions of development*. Considering simultaneously different dimensions in order to avoid counter-productive effects is not an easy task for highly differentiated administrations. More difficult still is to systematically look for synergies and win-win solutions. Different actors, different organisations, different disciplines will need to cooperate more fully.
- Sustainable development (SD) requires *openness towards the future* – for "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED 1987) we need not only to conserve potentials and resources but also to encourage innovation in the right direction and to improve the ability to learn. Learning may include the shifting of perspectives and priorities. Therefore, the concept of SD and corresponding assessments must also allow for changing objectives and priorities over time. Sustainable development is an open process. "Sustainability" can never be achieved definitively. Yardsticks change as your knowledge increases.

Two additional challenges emerge in formulating Sustainable Development policies at the European Union level:

- Across Europe the cultural, the political, the economic and the environmental contexts of development vary considerably. Nevertheless, European policies need a common framework that is able to deal with this *diversity of contexts*. Assessments will need to take into account differences between contexts and at the same time allow for comparisons. For transferring experiences, a description and an understanding of these differences is necessary.
- European policies often concern five or six political or administrative levels, from the European level to the local level. Transparency and participation are high priority principles of the EU. A coherent sustainable development policy across the Union requires *multi-level governance:* appropriate systems for ensuring co-ordination and an integrated view of the responsibilities and activities of all levels are needed.

Assessing Sustainable Development

These challenges arising from the concept of sustainable development lead to considerable difficulties in the assessment of "Sustainability" when using conventional approaches:

- How does one look simultaneously at different dimensions of development? How does one integrate different disciplines? How does one measure a balanced development?
- How does one account for changing views? How does one guide and encourage innovation?
- How does one account for different contexts and priorities in different European regions and cultures?
- How does one ensure transparency and shared responsibility across a hierarchy of political levels? How does one deal with such a wide range of issues and the complexities of their interrelationships over space and time in a dialogue between experts, politicians and the public?

Many attempts have been made to reduce the whole issue of Sustainable Development to a limited number of easily comprehensible indicators that can be measured and monitored using conventional means. These approaches have been very useful for gaining a quick overview. However, limiting the assessment to the measurement of a standardised set of indicators has not led to a satisfactory response to the abovementioned challenges. Such a conventional approach easily leads to the reproduction of a sectoral view– it is not able to deal with views and priorities which change over time, and often it is not felt to be adequate to the specific local situation. In practice, the wide variety of initiatives that have attempted to assess progress in the direction of sustainable development (such as local agendas, state programmes, companies etc.) have often devoted considerable efforts to developing very specific and detailed assessment systems with varying levels of success.

This wide variety of approaches has for a long time given rise to polemics that argued that the concept of Sustainable Development was without any precise meaning and therefore useless. However, despite the difficulties in giving precise definitions and assessment rules, the concept has not lost its attractiveness and political effectiveness. Reviewing the main EU research projects concerning sustainable regional development three years ago, I was astonished at the extent to which a consensus concerning the main challenges of sustainable development had grown in only a couple of years (Schleicher-Tappeser & Strati 1999a). Today, we can build on a rather large consensus, as can practitioners, that SD is a useful concept that involves an open learning process, and that it makes no sense to give a detailed universal measurement rule for "sustainability".

We therefore need new approaches in assessing Sustainable Development. This is particularly true in the domain of public policies, where – mainly as a result of continued efforts of the European Commission – the concept of evaluation has made considerable progress in recent years, yet it is far from being generally understood. In the business world, the necessity of dealing with complexity and continuous change has led to several concepts that may be most useful in this context: "change management", "quality management", "learning organisations", are all concepts that have abandoned the old "command and control" approach and try to make use of systematic self-reflexive learning processes. Our democratic systems indeed rely more or less systematically on these kinds of feedback mechanisms – many administrations however, still operate on the basis of a rather conventional top-down logic and have difficulties in conceiving of assessments and evaluations as occasions for learning.

I think that understanding Sustainable Development as a collective learning process is the key to developing adequate assessment systems. Learning continuously changes the perspective concerning what could and should be done (the objectives) and how it could and should be done (means and methods). Assessments can help on both levels.

They can help in learning what should be done:

- by analysing a situation
- by identifying alternative developments and actions
- by specifying and revising objectives

And they can help in learning how to do better:

- by monitoring progress towards set objectives and refocusing actions
- by reminding that the different dimensions of development need consideration
- by comparing different approaches
- by exchanging experiences between different contexts.

To consider assessments as tools for learning implies that those who are involved in assessments should be interested in learning. On the one hand it is therefore important to motivate and to enable people to learn from these assessments. On the other hand we must recognise the long tradition of command and control and the limited openness to new approaches in many cases. Hence it is advisable to provide very simple assessment tools for simple cases.

The aforementioned concept of *Quality Management* seems to be particularly appropriate for developing a new assessment approach. Its widespread use in industry facilitates acceptance and understanding. Also, we intuitively accept that quality is always relative, it can never be reached absolutely. Quality Management means that permanent attention to quality is important at every stage of "production", everybody at all levels shares the collective responsibility. The emphasis of a quality management system lies on the procedures. Objectives and criteria are not fixed forever, they are re-examined on a regular basis. The transparency of objectives, continuous monitoring and regular evaluation are constitutive elements of such a learning system.

In the case of industrial environmental policies a paradigm shift from "command and control" towards "quality management" has already taken place: the introduction of environmental quality management systems has brought about a quantum leap in the efforts towards improved environmental performance. It has also shown how much still is to be learned. However, many examples demonstrate that minimum standards and their enforcement by public authorities do not by any means become obsolete. The same holds true for Sustainable Development: the concept of SD and the best assessment systems will never replace the highly differentiated system of regulations developed as a result of environmental, economic and social policies over the last two hundred years. But note that the concept of SD is something different, it amounts to more than the sum of these regulations and standards.

I distinguish between a "*defensive*" and a "*constructive*" approach to Sustainable Development. There are many administrators who would like to have an assessment tool that tells them that they do no major harm, which guarantees that nobody can blame them for supporting "unsustainable" activities. They would be happy with additional checklists leading to a final stamp which confirms that all is well. However, they are aware that final users would be reluctant to fill in another series of control forms in order to get public aid or service. Indeed, procedures of this kind could easily be integrated into conventional administrative practices, but they would not really add new elements to existing legal requirements (which surely could be improved), they would create supplementary complications in the name of sustainable development and would provoke resistance and de-motivation in the public. A less defensive and more constructive approach would need to involve the encouragement of learning and innovation.

Sustainable Quality Management

In order to respond to these challenges and to operationalise the concept of Sustainable Development without loosing its innovative and constructive characteristics, we have developed the system "*SQM – Sustainable Quality Management ®*" over recent years. Since 2001 it is being commercialised by the *SQM-praxis* company.

"SQM – Sustainable Quality Management ®" is a versatile system for the assessment and management of all kinds of sustainable development processes. Its basic concepts were developed in 1996-1998 in the INSURED ("Instruments for Sustainable Regional Development") EU research project funded by the ENVIRONMENT programme (Schleicher-Tappeser et al. 1997; Schleicher-Tappeser et al. 1998). Since then it has been further developed in a series of research and pilot application projects in different European Countries.

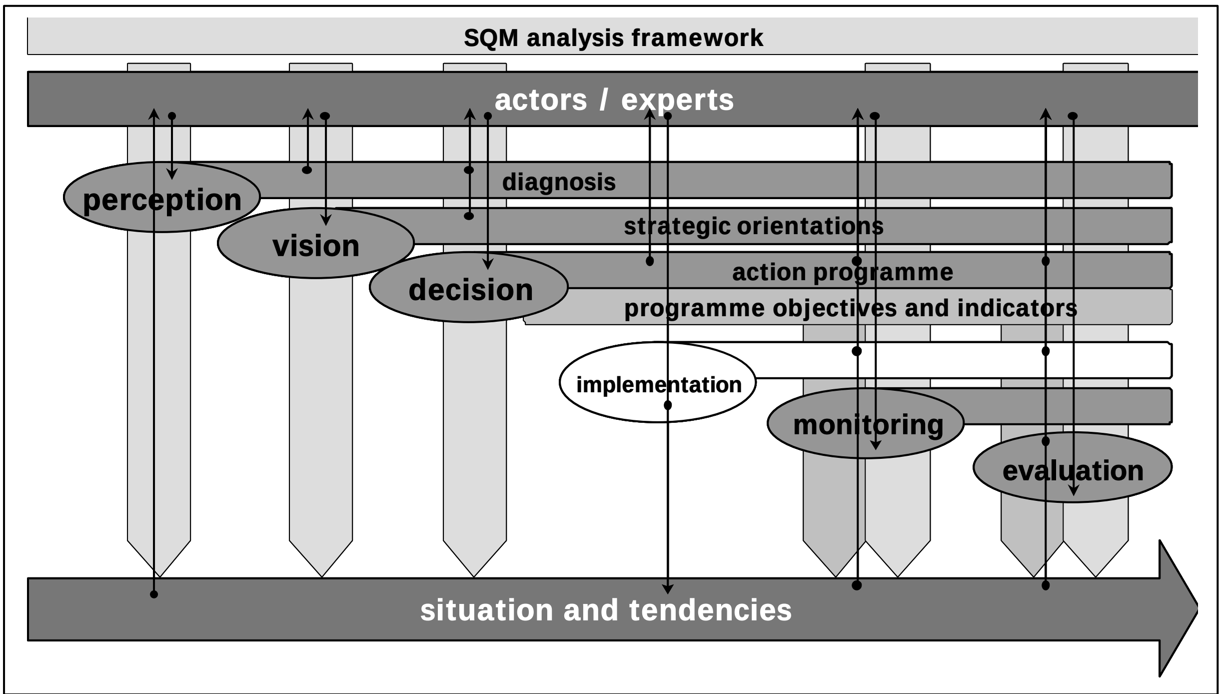


Figure 1: Use of SQM appraisals over the whole policy cycle

SQM is a modular system that can be adapted to a wide variety of different users and tasks. It consists of *concepts* (including the general analysis framework), a wide variety of application *methods* and internet-based software *tools*.

The SQM system has been constructed around basic appreciation procedures in order to provide support at every step through the whole policy cycle (see Fig. 1). Special attention is being given to developing a complete set of methods and tools for the management of Structural Funds programmes.

The *SQM analysis framework* consists of 32 rather general aspects that can be applied to and refined in different contexts. It can be regarded as a kind of "language" in which different points of view, priorities and contexts can be expressed. From the beginning, SQM has been designed to allow for intercultural exchange and discussion in Europe. In effect, this approach to providing a common framework of dimensions to be considered has proven to be most useful for intercultural communication.

SQM methods are designed to support learning processes and to facilitate the involvement of a large variety of actors: experts, administrators, politicians, local actors etc. They concern the appreciation technique itself, the facilitation of workshops, inquiries by questionnaires, the integration of given indicator systems, the development of strategies and programmes, teaching, and the exchange of experiences.

The *SQM online tools* combine these elements and provide efficient support for different users and tasks over the internet.

<table>
<tr><td colspan="3">SQM – Sustainable Quality Management
a modular system for the management of sustainable development processes</td></tr>
<tr><td colspan="3">Concepts
Sustainable Development as regulative idea and dynamic process …
Quality Management of development processes, evaluation …
Subsidiarity as a central concept of governance …</td></tr>
<tr><td>Framework</td><td>Methods</td><td>Tools</td></tr>
<tr><td>the SQM analysis framework
ORIENTATION:
10 Components of Sustainability
SOCIAL POTENTIAL
16 Regional Key Factors
ACTION DYNAMICS:
6 Basic Transformation Levers</td><td>diagnosis of situations
strategy and programme development
monitoring and evaluation of programmes and projects
SQM-appraisal combining qualitative and quantitative analysis
participative facilitation
synthesis and visualisation
training</td><td>Internet-based online-tools
SQM.guide: public guide to funding programmes
SQM.progman: tool for managing funding programmes
SQM.project: versatile expert tool for SQM-related projects
SQM.experience: experience exchange</td></tr>
</table>

Table 1: The SQM system

The SQM analysis framework

In order to provide a better understanding of SQM a short explanation of the SQM analysis framework and the actual assessment procedure are necessary.

The three groups of aspects contained in the *SQM analysis framework* are the answers to three simple questions:

- Which direction do we choose for our future?
  → The principles of sustainable development: ORIENTATION
- Which are the societal forces and the capacities for co-operation?
  → The local key factors for a sustainable development: SOCIAL POTENTIAL
- Which levers could be used for reorienting development?
  → The transformation levers: ACTION DYNAMICS

The ten components of the *ORIENTATION towards Sustainable Development* have been developed by comparing a very wide range of systems and definitions of sustainable development. It is possible to establish a full correspondence with the less systematic 21 principles of the Rio Declaration. The components of the ORIENTATION towards Sustainable Development are also based on three questions:

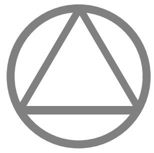
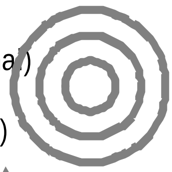
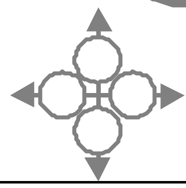
SQM analysis framework **The ten elements of ORIENTATION towards Sustainable Development**	
What do we want to sustain?	**The Development Dimensions** 1. Environmental dimension 2. Economic dimension 3. Socio-cultural dimension 
Which conflicts of interest are driving the debate?	**The Equity Dimensions** 4. Social and gender equity (inter-personal) 5. Equity between regions (spatial) 6. Equity between generations (temporal) 
Which basic approaches can help us?	**The Systemic Principles** 7. Diversity 8. Subsidiarity 9. Networking / Partnership 10. Participation 

Table 2: The SQM analysis framework

The first three elements are the common three basic dimensions of Sustainable Development with the third one encompassing what some other systems call “society” rather than merely the usual “social” aspects. These are looked at in more detail in the second group which has proved to be very useful for discussing the “future generations” issue in relation to other equity conflicts that have driven policies historically. The most innovative part is the “Systemic Principles”: they are a systematic synthesis of various underlying principles often mentioned in this context but usually not seen as core elements of the concept of Sustainable Development. To include these kinds of more basic orientations in practice requires some additional initial explanations, but it has proven to be extremely helpful in discussing essential relationships and in elaborating strategies.

The second major group of aspects in the SQM analysis framework concerns the *SOCIAL POTENTIAL*. Sixteen key factors for local sustainable development have been identified in order to describe the co-operation and communication structure in a given community. In fact, these elements allow for the identification of the obstacles and the particular potentials for promoting sustainable development in a given local or regional context. For the comparison of experiences in different contexts and cultures and for evaluating their transferability, a description of the contexts in these terms has been shown to be essential.

Finally, for analysing and designing actions, policies and programmes, the third group of the SQM analysis framework proposes the six basic “transformation levers” that describe the ACTION DYNAMICS.

The SQM assessment procedure

Depending on the specific appraisal task and the specific circumstances, an appropriate selection of these 32 rather general aspects is used in carrying out an SQM appraisal, e.g.

- for analysing the situation and the trends in a territory
- for analysing the intentions of a policy or a programme
- for evaluation proposals
- for evaluating projects and programmes
- etc.

The standard SQM appraisal consists of the following steps:

1. select the aspects to be considered
2. collect some key quantitative data concerning each aspect
3. carry out a qualitative SWOT analysis concerning each aspect (Strengths, Weaknesses, Opportunities, Threats)
4. attribute an importance to each single mention in the SWOT analyses (0 to 5 points)
5. attribute an importance to the Strengths, Weaknesses, Opportunities and Threats of each aspect
6. synthesise these latter importances to a graphical profile that allows to identify the "hot spots"
7. compile the most important single mentions concerning Opportunities and Threats for the identification of where more detailed analysis is necessary or for planning concrete actions
8. define sub-aspects for a more detailed appraisal where appropriate
9. identify indicators for detailed monitoring where appropriate.

The central element of this procedure is the SWOT analysis. Its advantages in this context are that it allows in particular

- the inclusion of qualitative appraisals by experts and laymen and the refinement of the analysis step by step as appropriate:
- the discussion of the dynamics of a situation and the discovery of new opportunities by examining the Weaknesses and the interrelationships between different aspects
- the structured collection of concrete ideas for action
- the provision of a framework which is equally useful for group discussions and individual questionnaires, and for the inclusion of highly precise expert information and for the representation of the more general perceptions and priorities of local actors

For involving less experienced participants it is advisable to translate the general aspects into questions which are more pertinent to the actual task and situation.

ORIENTATION		**S**	**W**	**O**	**T**
O1	Environment				
O2	Economy				
O3	Socio-Culture				
O4	Equity between individuals				
O5	Equity between territories				
O6	Equity between generations				
O7	Diversity				
O8	Subsidiarity				
O9	Partnership / Networks				
O10	Participation				

Table 3: Example of an SQM profile

Experiences in using the SQM system

An early successful experience with parts of the SQM framework involved a dialogue project between seven European regions. Representatives of the environmental administrations of Emilia-Romagna, Rhône-Alpes, Midi-Pyrénées, Vorarlberg, Baden-Württemberg, Wallonie and the Province of Gothenburg had come together in a series of workshops to draw common conclusions from their experiences with sustainable development projects. However, they had serious difficulties in agreeing on a common terminology and on a framework for evaluating their projects. The later introduction of the SQM framework allowed the formulation of the differing priorities in the interpretation of SD, the considerable improvement in the mutual understanding of those of very different backgrounds, the evaluation of the projects within a common framework, the discussion of the transferability of experiences and the formulation of a series of pertinent conclusions and recommendations concerning SD policies at the regional level. Particular advantages of the framework were shown to be that it allowed the formulation of different points of view and priorities within the larger debate concerning SD, that the basic categories could be understood in different cultures, and that assessments using this framework were very suitable for a collective learning process (ARPE, Schleicher-Tappeser & Faerber 1997).

An important occasion for testing and promoting the SQM approach was a series of twelve pilot projects funded by DG Regio concerning the integration of the concept of Sustainable Development into the Structural Funds. The project, carried out in Midi-Pyrénées, was based on SQM and consisted of a participatory programme development in two small Objective 2 areas. In each of these areas, a working group of local actors went through an intensive learning process, developing a common perception of the difficult and conflict-burdened territories, analysing previous interventions, identifying the main challenges, formulating key strategies and defining the basic structure of a programme. A project team facilitated the workshops, conducted supplementary interviews and synthesised the results of workshops and questionnaires. The second generation of supporting SQM software was developed in parallel with the project. In both territories, the SQM approach proved to be very useful in helping to examine the local situation from an unusual perspective. This allowed local actors to overcome old disputes and to develop genuinely new common visions. However, it was clear that competent facilitation was necessary in order to find the right balance between breaking up old stalemates and ritual discussions on the one hand and providing the security that a useful result would emerge on the other hand. Feedback from the local actors and the results were very positive although some lessons had to be learned concerning a simplification of the procedures (ARPE & Schleicher-Tappeser 1999). In the evaluation of the twelve pilot projects carried out on behalf of the EU commission, SQM was considered to be the most advanced system in this context (Moss et al. 2000).

Subsequent projects in Midi-Pyrénées also showed that with simplified procedures an SQM-based participatory programme development inevitably takes a longer time than the more usual top-down programming. A Franco-German cross-border development project in a small rural area on the Rhine confirmed later that larger SQM appraisal questionnaires can only be used with people with a certain experience in systematic development discussions: for local actors at the village level without other representative experiences, workshops seem to be the only adequate method of involving them into SQM-based discussions on community development.

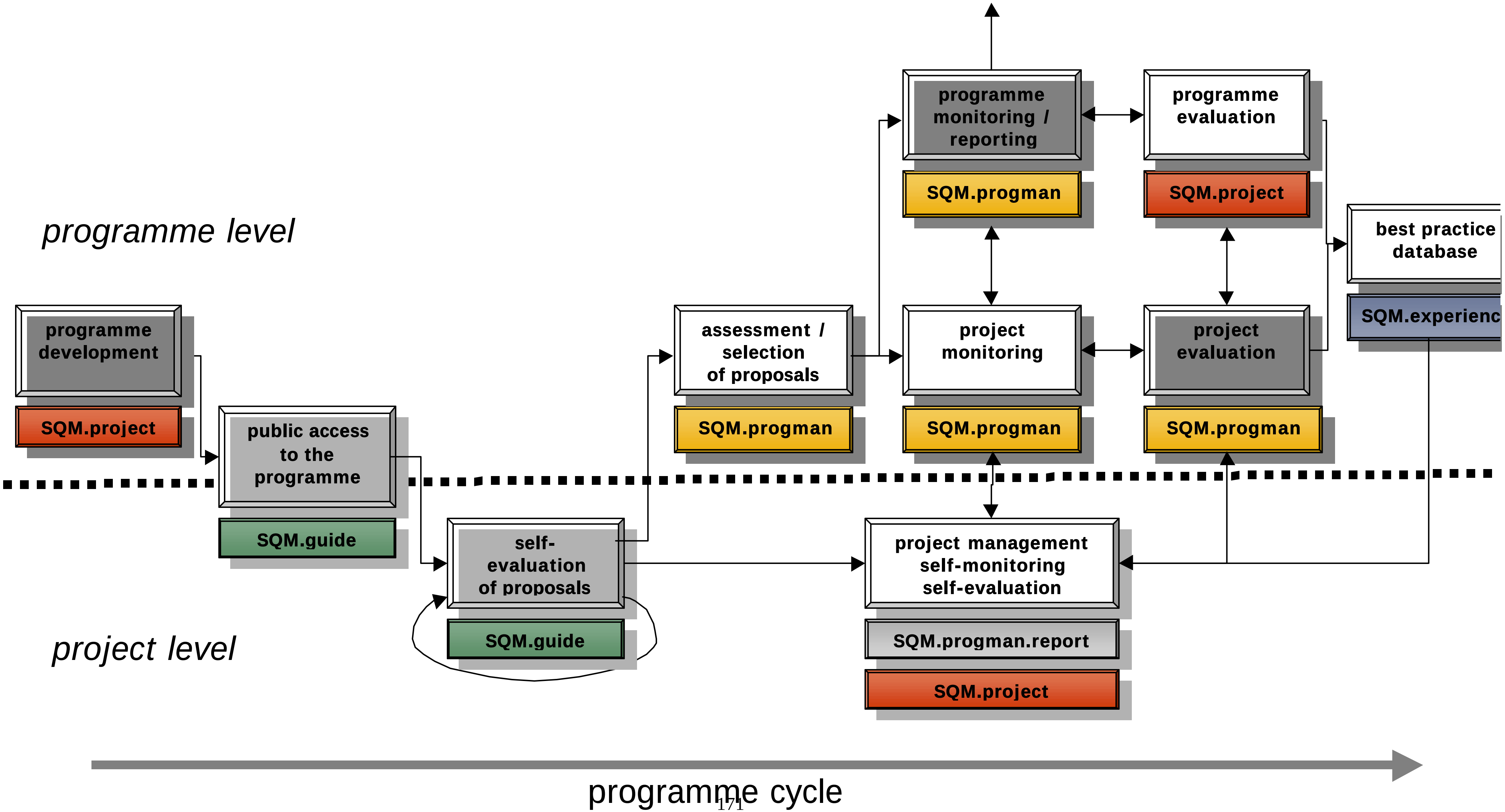
Whereas programme development is a creative process which requires experienced guidance with sensibility and flexibility, subsequent tasks in the management of the programme can be structured in a more formalised way. For the current Structural Funds programmes in Midi-Pyrénées we are now implementing a public website consisting of a public guide to the complex programme including the opportunity for project proposers to pre-evaluate for themselves their project proposals in terms of Sustainable Development and the objectives of the programme. A series of difficult questions had to be solved in transferring adequately the experiences of direct consultation to the anonymous format of the internet (see www.sqm-praxis.net).

SQM – Examples of projects	
1998:	Towards Sustainable Development: Experiences and Recommendations of seven European Regions. PACTE programme. (FR, IT, BE, SE, DE, AT)
1998:	Development of procedures for the consideration of SD criteria in the awarding of Structural Funds. Saxony (DE)
1999:	D2MiP: a DG Regio pilot project in Midi-Pyrénées (FR) concerning the participatory elaboration of local objective 2 programmes. Evaluation by DG Research.
2000:	Proposal of a charter for the Local Agenda 21 in Florence (IT)
2000:	PROMETEO: CD-ROM for supporting project development respecting the principles of SD for the Engineers Association of Cosenza (IT)
2000-01:	KARMIS: Cross-border landscape development scheme Marckolsheim-Sasbach-Endingen (FR/DE).
2001-02:	SQM.guide MiP: internet-based programme guide for the Midi-Pyrénées structural funds with auto-evaluation facility for project proposals (FR)
2001-02:	D2ParcsMiP: Programme development for 3 Regional Natural Parks in Midi-Pyrénées (FR)
2002-04:	INNESTO: EU research project concerning "Sustainable District Logistics" (IT, DK, DE, SP, NL)

SQM online tools

On the basis of these experiences *SQM-praxis* is now creating a third generation of software tools which will be available online via the Internet. This allows the provision of an integrated modular system of tools for all tasks that occur in managing public funding programmes. The coherent, and at the same time flexible, structure based on the SQM concepts allows the implementation of complex management systems with differentiated access rights for all those working in such a programme, ensuring transparency, ease of communication and coherent monitoring and evaluation. Better projects, more transparent programmes, more focused activities, more meaningful evaluations, and finally also reduced costs should result.

Fig. 2: Use of SQM online tools in the context of public funding programmes



Consequences for Research Policy

Sustainable Development is a new paradigm with far-reaching consequences. It is not a new discipline. The understanding of the full range of implications of this new concept and its dissemination will take a long time. In particular, SD will have deep consequences for the cooperation between disciplines and for the relationships between researchers, policy-makers and the public. Therefore, research policy should provide room and funding for probing basic questions and for new forms of dialogue.

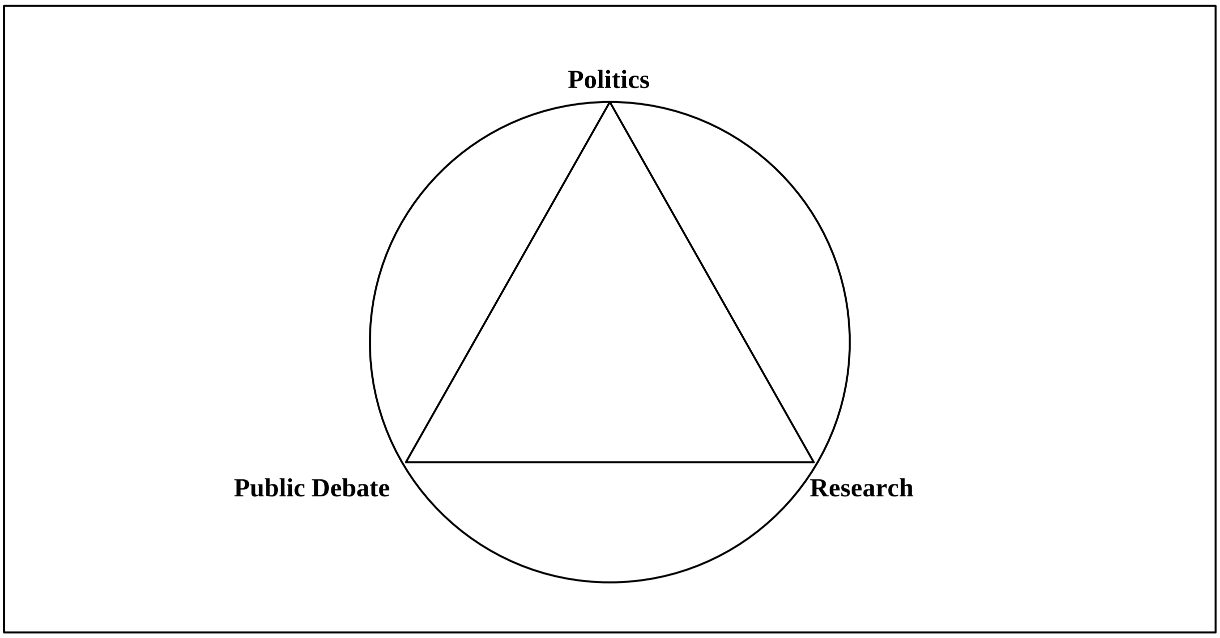


Figure 2

Research is increasingly becoming directly involved in complex collective learning processes with feed-back mechanisms that are accelerating. Research policy therefore must develop more intensive links to other policy fields and to the public debate.

SD encounters resistance and its label is being misused for reselling old approaches. Therefore it is important to monitor the changing use of this concept and to build bridges in the form of exchanges of experience and simple but challenging tools. Research policy, in my view, should actively assume an important role in the societal learning process associated with the transition from the industrial development paradigm to the emerging sustainable development paradigm. It therefore should try to provide adequate instruments for supporting this process.

Intercultural co-operation and confrontation is essential for understanding the role and the potential of the concept of SD. As a paradigm shift involves the difficult questioning of assumptions and perspectives previously taken for granted (Kuhn 1967), confrontation with the views of other cultures can be as fruitful as confrontation with other disciplines. Europe has a unique opportunity in this sense – several highly developed cultures have developed different approaches towards the same issues, they have a common basis for understanding and they now also have common institutions. This results in a dual challenge. On the one hand European intercultural research has specific innovation potentials which are usually underestimated. On the other hand it is becoming increasingly evident that European integration that takes advantage of the rich variety of European cultures needs a new form of governance in which the SD principles seem to be essential.

As SD calls for the integration of different development dimensions, it becomes more and more important to integrate social science considerations into issues that until now have mainly been treated as technical or natural science issues. Whereas European co-operation in technology and natural sciences is relatively easy and well-developed as concepts and methods do not differ significantly between different European cultures, co-operation and mutual understanding in social sciences is much more difficult. We have seen that in many European projects where a real partnership prevented the easy dominance of one approach over another and forced genuine confrontation and comparison of different perspectives this difficult, and for many unusual, intercultural questioning process was a major source of innovation (Schleicher-Tappeser & Strati 1999b; Schleicher-Tappeser & Strati 1999a). However, the resources which are necessary for this process have generally been underestimated. The trend to “think big” in the discussions concerning the new European research programmes could result in destroying a culture of innovative cooperation that has evolved in recent years: in order to minimise risks, managers of large projects will tend to limit intercultural cooperation to more technical issues.

In order to promote Sustainable Development in the policies and actions of the European Union, a much improved cooperation between researchers and practitioners is needed. Research provides concepts, but practitioners require ready to use tools for communication, management and teaching. Today such tools also need software support, which is very expensive to develop. The result of present funding structures is that there is a considerable gap between interesting concepts on one side and the practical short-term needs for management and evaluation on the other. The pragmatic solutions for evaluation, management and training developed under extreme time and funding constraints generally do not correspond to the much more advanced state of the art concepts and knowledge resulting from research. Improved cooperation, for example, between DG Research and DG Regio could result in more adequate funding and practical experimentation and testing opportunities for the intermediate development stages of learning and management systems.

Europe, with its variety of traditions and cultures, with its long history of political and intellectual struggle for combining cultural, economic, social and individual development in a rich and varied but restricted environment, has a unique chance to play a leading role in the transition towards more sustainable development. Research policy should meet this challenge by mobilising and recombining these specifically European resources and making them accessible for a collective learning process.

References

More detailed information and literature concerning SQM can be found on the web-site www.sqm-praxis.net. Most references quoted here are available as downloads.

ARPE, Agence Régionale pour l'environnement de Midi Pyrénées/ Schleicher-Tappeser, Ruggero, (1999): D2MiP: Développement Durable en Midi-Pyrénées - programmation pilote des Fonds Structurels. Rapport Final. Toulouse: ARPE.

ARPE, Agence Régionale pour l'environnement de Midi Pyrénées/ Schleicher-Tappeser, Ruggero/ Faerber, Johanna, (1997): Towards Sustainable Development. Experiences and Recommendations of seven European Regions. Toulouse: ARPE.

Homann, Karl, (1996): Sustainability: Politikvorgabe oder regulative Idee? In: Gerken, L.: Ordnungspolitische Grundfragen einer Politik der Nachhaltigkeit p. 33-47. Baden-Baden: Nomos.

Kuhn, Thomas S. (1967): Die Struktur wissenschaftlicher Revolutionen. Frankfurt.

Moss, Timothy/ Fichter, Heidi/ Glimm, Daniela/ Kraemer, Claudia, (2000): Regional Pathways to Sustainability. Experiences of Promoting Sustainable Development in Structural Funds Programmes in 12 Pilot Regions. Luxembourg: Office for Official Publications of the European Communities.

Schleicher-Tappeser, Ruggero/ Lukesch, Robert/ Strati, Filippo/ Sweeney, Gerry/ Thierstein, Alain, (1998): Instruments for Sustainable Regional Development. The INSURED Project - Final Report. (=EURES-Reports, REP-9). Freiburg: EURES-Service.

Schleicher-Tappeser, Ruggero/ Strati, Filippo, (1999a): Progress towards Sustainable Regional Development. A review of results from the EU Research Programme on Human Dimensions of Environmental Change. Luxembourg: Office for Official Publications of the European Communities.

Schleicher-Tappeser, Ruggero/ Strati, Filippo, (1999b): Sustainability - A New Paradigm for Research? In: Catizzone, M.: From Ecosystem Research to Sustainable Development. Towards a New Paradigm for Ecosystem Research (=Ecosystem Research Reports N° 26, p. 45-58. Luxembourg: European Commission. ISBN 92-828-6425-1.

Schleicher-Tappeser, Ruggero/ Strati, Filippo/ Thierstein, Alain/ Walser, Manfred, (1997): Sustainable Regional Development. A comprehensive approach. (=discussion paper). Freiburg: EURES-Service.

WCED, World Commission on Environment and Development (1987): Our Common Future. Oxford: Oxford University Press.

Synthesis of Session 1
European research policy meets Sustainable Development

R. Loskill

Forschungszentrum Jülich, Projektträger Jülich des BMBF
D-52425 Jülich – Germany
r.loskill@fz-juelich.de

Core topics of the session

Session 1 of the workshop spanned the whole range of events which, beginning with the Bonn workshop in January 2001, have influenced developments with regard to both **European *sustainable development policy*** *(SD policy)* and **European research policy**. In his introductory speech, Yvan Ylieff, the Belgian Government Commissioner, described the political and scientific state of the art and explained the objectives of the workshop. The papers subsequently presented by scientists and representatives from the European Commission analysed the major events and processes from different angles and described objectives, results, background information and scientific analyses. The following summary of session 1 covers three overarching core topics:

- the political context of European research policy for sustainable development and the interactions between science and SD policy
- developments regarding the Sixth EU RTD Framework Programme and
- the achievements of European research to date with regard to sustainability needs.

European research and European SD policy: 2001 – an exciting year

The workshop "Setting Concepts into Motion: Sustainable Development and R&D Policies" held in Bonn in January 2001 brought together people who are engaged in European research policy for sustainable development or who are concerned with its implementation in the scientific and business communities. The crucial question of the workshop was: What can and what should European *research for sustainable development (SD research)* achieve and what are the characteristics of such research?

These discussions were resumed and continued at the Brussels workshop. In addition, other **forums and workshops** and also major **scientific conferences** have covered the sustainability topic in the course of the current year, e.g. the Amsterdam workshop held in January on research and environmental policy and the Bridging the Gap Conference, which took place in Stockholm in May. Several informal discussions on strategic issues were held by the member state representatives, who are members of the Environment and Sustainable Development research programme committee under the ongoing Fifth EU Framework Programme. These discussions helped to clarify opinions, and certainly helped to reach a degree of common understanding of what can be expected, and what should be expected from European SD research.

For further concretisation, and for specific implementation of SD research, questions will have to be answered such as: what tools will SD research use, and what tools will it have to develop to assist policy in achieving sustainability goals. It will be necessary, in addition, to take stock of and jointly evaluate national initiatives concerning research for sustainable development in the member states. The ESTO study of the IPTS is aimed at evaluating the research programmes of several member states in terms of sustainable development. Its results will be presented and discussed in Seville, where the next workshop will be held. Seville will thus be the follow-up of the Brussels workshop.

Apart from these informal events and scientific analyses, a number of **official documents provided milestones** which determined European environmental policy, policy for sustainable development and European research policy, respectively. These documents include the Commission's proposal for the Sixth EU Research Framework Programme presented in February 2001, the Commission Communication on the European Union Strategy for Sustainable Development and the White Paper on European Governance, the common position on the Community Environment Action Programme 2001-2010, and the documents submitted by the Belgian Presidency in preparation for a common position on the Sixth Framework Programme.

Even more important was the crucial **decision taken by the Göteborg European Council** in June, as a step towards practical and comprehensive implementation of sustainability measures in Europe. Through this decision, governments committed themselves to a common strategy for sustainable development, which has its roots in the Brundtland Report, the Rio Conference and article 6 of the Amsterdam Treaty.

The political context: The Göteborg European Council

The Göteborg decision on a common European strategy for sustainable development would not have been possible without preparatory work **linking political aspects and scientific expertise**. Such linking has become a rather frequent approach: The Commission's White Paper on European Governance, for instance, is based on scientific reports such as the paper on "Democratising Expertise and Establishing European Scientific Reference Systems". Member state governments also use scientific findings to support their SD policy: Belgium's use of the "Scientific Plan for a Sustainable Development Policy" is an impressive example. The Commission's Communication "A sustainable Europe for a Better World: A European Union Strategy for Sustainable Development" presented in preparation for the Göteborg Summit provided a basis for reaching political understanding between member states. Per Sørup gave us a glimpse into the IPTS's work for scientific policy support, and Uno Svedin gave a general analysis of the matching between overall SD policy and SD research policy.

The most important **results and the general conclusions from the Göteborg decision** are:

- By implementing the European strategy for sustainable development, Europe will, according to Christian Patermann, assume a pioneering role among world regions with regard to sustainability. Sustainable development has been given a prominent position on the political agenda of the Community.
- In Göteborg, the following four priority areas were defined for the implementation of the European strategy for sustainable development: Climate change, transport, public health and natural resources.
- The Göteborg Council also identified specific fields of action, e.g. electricity generation, renewable energy, common agricultural policy, and fisheries policy.
- The challenging task now to be tackled by *policy makers* is to solve the problems existing in the priority areas and implementing the necessary measures in the action fields identified. A new approach to policy making will be needed for most of the problems. Also, the EU strategy for sustainable development will have to be reviewed, and to be developed further in the future.
- The challenging task to be tackled by *R&D players* is to support policy-makers and provide the innovations required to achieve the ambitious goals.
- Generally speaking, Europe must also keep the global dimension in mind.

The Göteborg European Council: challenges to be met by policy-makers and scientists

Specific tasks and pertinent time schedules for European policy can be derived from the Göteborg Council and subsequent processes. Despite the urgency of some matters, it will be necessary to rely on new research results and innovations. Thus, an immediate consequence of the Council decision are the "**Göteborg requests**" addressed to the scientific community. The requests concern e.g. the priority areas of the EU strategy for sustainable development, where a research need exists for example with regard to sustainable energy production and sustainable energy use, and the management of natural resources. In addition, policy-makers urgently need specific and new scientific tools for meeting the requirements of the further political process.

Pierre Valette explained these connections in his paper, which listed a number of specific examples of the policy demands with respect to research. Two such topics are "Headline

Indicators for the Evaluation of Sustainable Development Implementation" and "Sustainable Impact Assessment". These research issues should be jointly tackled, in accordance with the principle "a common approach to a common issue", since the European strategy for sustainable development concerns the Community as a whole.

In addition, the scientific community is called upon to support the implementation of more **long-term, systemic innovations** in politics, the economy and society which are required as a consequence of the European sustainable development strategy, and the sustainable development concept. Angela Liberatore's paper analysed in detail the field of politics, making visible various links between, or common features of sustainable development and the concept of good governance. While the relevant goals are fundamental in nature, they are also of great importance for the European road to sustainability. These goals include enhancing democracy, overcoming "sectorialism", tackling distributive aspects, avoiding short-termism and others.

In order to achieve these goals, we need new policy approaches and a supporting new research approach. Uno Svedin presented an analysis of the situation: key features of the challenge to be met by SD policy include the transition to a multidimensional-systemic approach, the establishment of consultative and participatory procedures and the global connotation. Research must be systemic (interdisciplinary, cross-sectoral etc.), it must have a medium or long-term perspective, it should invite actors to participate, etc.

An overall view of the topic reveals that research and the process of research policy opinion-forming does have a concrete impact on the process of European SD policy, and the political processes in turn have an impact on research. It can be noted that these connections may in the future become even closer and more obvious.

Sustainable development research in the Sixth Framework Programme

The working documents for the Sixth Framework Programme already reflect the Göteborg decision. This can be noted both in the papers presented by the Belgian Presidency and in the modified proposal submitted by the European Commission. Christian Patermann's paper gave an overview of the opportunities and perspectives of SD research in the new Framework Programme. As regards **goals**, it has been confirmed that research must

- take into account and integrate the three pillars of sustainable development and
- pool Europe's research capabilities.

These goals concern the sixth priority in particular, but they are also important for the other research activities, and they underpin the establishment of the European Research Area.

A direct reflection of the Göteborg requests can be found under the sixth priority with its three fields of **thematic approaches:** energy, transport, and global change/ecosystems. New aspects, including sustainable land use, were introduced into chapter 1.1.6 during the negotiations to establish a common position. The other thematic priorities also support the European strategy for sustainable development, e.g. in the thematic fields of health research, and governance. Last but not least, policy-supporting research from the former eighth priority is expected to make a considerable contribution to SD research. It is important to look at the framework programme as a whole when trying to measure its contribution to the sustainable development issue.

The Sixth Framework Programme opens up new opportunities not only through its objectives and thematic approaches, but also through its **instruments**. Integrated projects and networks of excellence are the new research tools proposed by the Commission. In addition, it is now possible in selected areas to make use of article 169 of the EU Treaty: the Community may participate in the research and development programmes undertaken by several member states, in mutual agreement with the member states.

The discussion on whether European SD research can be or should be implemented in connection with the Sixth Framework Programme and in accordance with article 169 was first started in session 1 and was continued during sessions 2 and 4 of the workshop. Some proposals for possible research topics are listed in the annex.

Achievements of European research for sustainable development

The surveys presented in session 1 by several speakers of what has been achieved in the past show that European research has already treated in some detail topics and problems that are relevant to the sustainability discussion. There have actually been achievements in two respects:

First, with regard to **thematic approaches and solutions**, where, obviously, many efforts are under way. We looked at a map of Europe showing the thematic approaches taken by the scientific community. We learned about several projects and clusters – highlights from the framework programmes of European research funding. We were given a survey on topics and figures, which revealed that the Fifth RTD Framework Programme contains visible topics for research in the context of sustainable development.

Second, some progress has been achieved in identifying the typical **features of SD research** – its **general nature and its characteristics**. We have reached the point at which we can point to results. Summing up the papers, we can name the following characteristics, thereby providing a tentative basis for the final process of agreeing on the following results:

- systems features (Inter-disciplinarity, cross-sectoral approach, etc.)
- problem-solving research
- actors' presence
- inclusion of socio-economic aspects
- governance embedded
- long-term perspective (or medium-term perspective).

Session 1 left open how such characteristics might be applied in practice as criteria at the level of research programmes and of individual projects. Session 3 of the workshop will contribute some interesting aspects concerning this question.

Research for sustainability: some examples of topics

Policy demand:
Monitoring and assessment tools and indicators
Common evaluation criteria ("relevance criteria")
Best practice and transferability

Bonn topics (examples):
Integrated ecosystem management
Global governance – global change
Role of RTD for policy-makers and society

Some elements from the discussion:
Cultural landscape research
Integrated product policy

Synthesis of Session 2
Sustainable research and article 169. What is “article 169” and why could it be interesting for sustainability research?

Andreas Geisler

Federal Ministry of Education, Science and Culture
Department of Environmental Research
Rosengasse 4 - 1014 Vienna
Austria
andreas.geisler@bmbwk.gv.at

Article 169

Article 169 of the Treaty of Amsterdam states: "*In implementing the multi-annual framework programme the Community may make provision, in agreement with the Member States concerned, for participation in research and development programmes undertaken by several Member States, including participation in the structures created for the execution of those programmes*". (European Union, 1997)

On its 2380th council meeting on research, 30th October 2001, the European Council invited

- *"- Member States to identify possible specific topics for pilot programmes where the use of article 169 would be appropriate, in close liaison, where necessary, with the Commission, and to explore the possibilities offered by fora such as Eureka and COST;*
- *all interested Member States to examine, with the Commission, the detailed modalities for the implementation of joint programme proposals, paying particular attention to the financial aspects, the relative advantage of the use of article 169 over other instruments and the criterion of European added value;*
- *the Commission to come forward by early 2002 with proposals to the Council and European Parliament for participation by the Community in any such pilot programmes, as well as on the rules and procedures for financial support in relation to these pilot programmes following contact with the Member States concerned."*

Therefore, article 169 offers the possibility of Community RTD funding outside the Framework Programme's mechanisms where the initiative comes from the member states.

However, the funding itself will be provided for from the Framework Programme budget, and reference is made to the Framework Programme alongside which – necessarily – any article 169 effort has to be implemented.

Since article 169, so far, is "law without application", the potential for application has to be interpreted by the interested parties. On basis of the Commission communications on the 6th Framework Programme and application of article 169 (European Commission, 2001a,b), the CREST opinion "Synergies of National and European RTD Activities" (CREST, 2001) and a national assessment, the following framework conditions have to be considered (Pichler, 2001):

- Initiatives should reflect the Framework Programme's thematic priorities.
- Initiatives should reflect justifications for European added value as well as for choosing a non-Framework Programme approach (bridging the gap between the centralised Framework Programme and subsidiarity approaches).
- Initiatives should aim primarily at areas where there is – by their very nature – a large share of public goods involved in order to prevent pre-competitive scenarios not well balanced among member states, thus reducing the probability to reach a council decision.
- Therefore, article 169 efforts will be launched by a core group of member states, whereon all member states potentially can embark.
- Within the area chosen, each participating member state should commit the majority of its respective activities at national level.

What will formally be required is that:

- article 169 is not to be seen as an instrument of the Framework Programme – even though reference is made to it in Annex III of the 6th Framework Programme proposal in order to provide for future funding of article 169 actions –, it rather leads to a Community RTD programme of its own since it requires a legislative act (a decision of the Council an the European Parliament) at the same level as for the Framework Programme; a simplified framework procedure was recently rejected by the European Parliament.

- Therefore, any article 169 initiative will require the legislative act itself (decision), the scientific and technological objectives (annex I), the amounts (annex II), and the instruments (annex III).
- As a greater challenge, each of these issues has to be cared for at national level of the member states involved and their respective programmes.

Given these preconditions, it is clear, that any application of an article 169 initiative requires a large effort of mutual information exchange, co-ordination, and trust between the member (and associated) states, the European Parliament and the European Commission.

Why could co-operation on basis of article 169 be interesting with regard to sustainability research?

- Sustainable development research is very broad by its nature.
- Sustainable development research has to integrate different spatial scales: Considering the principle of subsidiarity, therefore “meso” level actions could fill the gap between local and European research co-operation.
- Sustainable development asks for a paradigm shift on how research is performed, related to its nature of inter- and trans-disciplinarity, strong stakeholder involvement and the number of dimensions involved. In this context, evaluation criteria for sustainable development projects need to be further elaborated.
- Co-operation on sustainability research can be a driver for further co-operation in sustainable development policies.

In general, implementing sustainability needs a lot of awareness making activities, overall concepts, the necessary technological solutions, demonstration, dissemination and take up, very often also incremental steps and numerous smaller projects (co-ordinated in an umbrella) on a regional level, and making use of best practice experience. In a globalised world, it also needs co-operation across borders.

Not all answers can be given on the Framework Programme or national or regional level alone. A complementing approach by a tailor-made co-operative initiative of interested EU member states could fill a gap on a so-called meso level, that allows to integrate the economical, social and ecological pillars of sustainability research, the diversity of scales and the building of common methodologies of inter- and trans-disciplinarity.

The Brussels workshop - One step forward

It was the aim of the first day of the workshop, at least partly to answer five critical questions:

– First, the workshop should help to identify possible priority areas that could be starting points for a first application of article 169 programmes.
– Second, to build on already existing initiatives, a map should be built, whether all countries (member and associated states) do have sustainable development research activities.
– Third, it was the aim to elaborate what would be the best-suited instruments (for example research organisation, selection of proposals, evaluation procedures).
– Fourth, if this would be the case, the discussion was intended to focus on the question, how a better co-ordination could be achieved?
– And fifth, if there is the will and potential to co-operate on specific topics, the workshop should help to come to a preliminary conclusion, whether article 169 is well suited or if other modes of co-operation would be more appropriate.

Several possible *priorities* for co-operation were identified, which are summarised by the rapporteur of the first session, Renate Loskill.

Concerning the *second question*, the presentation of Matthias Weber confirmed (Weber, 2001), that several countries have clearly defined sustainable development programmes. However, these programmes show considerable differences in organisation, are either umbrella or sector specific programmes and are problem- or cause-oriented. Furthermore, differences concerning mono- or multi-disciplinarity, the involvement of different actors (stakeholders), the main focus on technology or "soft" sustainability science (planning, management, economic and social incentives) as well as the individual development of assessment criteria and monitoring tools underpin the very diverse character of national sustainable development research programmes. Nevertheless, there is a large potential for co-operation on basis of the national programmes; the main question being how to do it. Challenges ahead are mainly seen in the institutional context.

With regard to *best suited instruments*, experiences from the Austrian Landscape Research programme (Krott, 2001) that could be given forward are, that evaluation should particularly focus on success stories and to drive research projects towards success factors, since the majority of research projects working on sustainable development will not be successful in changing the policy agenda. The success should by all means be made visible for stakeholders.

Trans-disciplinary research unconditionally requires strong disciplines and therefore “minimal” (i.e. still on a very high level) disciplinary standards. The search for success should be repeated for many times, since the impact of certain projects can only be measured after years. Sustainable development research programmes should be steered by meta-scientific evaluation, to avoid a too large concentration on home made methods (logic & economics), to avoid too much consensus (political selection by practice) and to mirror the (true) driving forces of research. (This, in fact, is a strong argument for article 169 co-operation.) Evaluation by politics can be achieved by budgeting through modules, creating markets for strong interests and by applying lighthouse communication.

Further requirements and recommendations regarding sustainable development research were brought up by Silvio Funtowicz (Funtowicz, 2001). In general, there is a strong need for social robust knowledge as well as overcoming communication gaps between scientists, policy makers and the general public. Therefore, involvement of stakeholders from the beginning (which kind of participation processes?), as well as inclusion of knowledge obtained in local history, traditions, innovative practices and thus an extended peer community, are seen as ultimate prerequisites for successful sustainable development research, which particularly is characterised by complexity. The links of sustainable development research to the White Paper on European Governance have also been stressed.

When facts are uncertain, values in dispute, stakes high and decisions urgent, we particularly have to focus on two essential questions:

– What is the problem?
– What the solution?

With regard to the second question, trans- (disciplinary?) science could be the way forward.

Discussion on co-operation and article 169

Building on the presentations, the final discussion on the first day of the workshop was intended to particularly concentrate on how a better co-ordination could be achieved, if there is the will to co-operate and whether article 169 is well suited or if other modes of co-operation would be more appropriate.

Central issues of sustainable development research

A central issue raised was, if (and how) the science policy interface in sustainable development is different to other areas. It is not clear by now, what the needs of the policy community regarding sustainable development are. Linked to this question is another one, namely at what time research input is required for policy making. To assure success of sustainable development research programmes, sensitive priorities of European policy (e.g. fisheries) should be addressed.

Co-operation and co-ordination

With regard to the 11 September, a clear statement was made that from now on, we do live in a global society. Therefore, there is a strong need to open the doors for incorporating actors beyond a national level.

Researchers are the stakeholders addressed to concretely conduct research jointly. It was pointed at, that (at least a part of) the researchers do have enough money from national funding, so why should they go to co-operate on the European level? Quite often researchers don't know in what programme they are in; their main interest lies in pursuing their individual research strategies.

A prerequisite to bringing research programmes to the European level is a certain "maturity" of these programmes. Also small-scale issues should be discussed on European level. Since Europe is so diverse: How similar will research questions really be in Europe? The suitability of article 169

In general, it was questioned, if the "high level of 169" really is the adequate one to co-ordinate this "diverse landscape". The commission confirmed that article 169 means "high level co-ordination" by definition. “Low level co-ordination”, e.g., would be the implementation of an information system. Since the timeframe is strict, clear targets for a first application of article 169 would be required.

On the opposite, article 169 co-operation also was considered as an excellent opportunity for several programmes to bundle forces. Article 169 really could add value and the European Commission could collect experience. An image was brought up to think on what will happen, if we don't make use of the article 169. The use of other instruments will of course be possible, nevertheless, for some topics only article 169 would be the right instrument.

More “169 critical” statements emphasised that concerted actions could be the right means to co-operate on sustainable development research, that the level of integration depends on the issues and that the plenty of mechanisms available should be made use of.

With regard to the solution of problems, it was recalled that instead of focusing too much on article 169, we better should identify the core questions, then consider the instruments, and if FP6 would not be the right instrument, we should make use of others.

Conclusions

Session 2 of the workshop allowed to come up with some preliminary results:

- More or less all member states do have sustainable development research activities, but not all do have research programmes.
- There are a lot of different procedures of funding and conducting sustainable development research activities/programmes.
- A better co-ordination can be achieved from small steps (e.g., concerted actions) to joint article 169 programmes.
- There is some interest in article 169 co-operation, but the majority of the present member states behave reserved.

However, also a bundle of questions remained for further discussion:

- Do several countries intend to co-operate on sustainable development research?
- If yes, which countries will concretely put efforts in an article 169 co-operation on sustainable development research to be considered already in the 6th Framework Programme?
- With regard to which concrete priorities?
- If not article 169, is there an interest for other (lighter) modes of co-operation?
- Is it too early for these questions?
- What could be the next step outside the 169 debate?
- How to build up multi-lateral trust?

References

CREST, Scientific and Technical Research Committee, 2001; Aspects of ERA in the Commission's Proposal for a new Framework Programme 2002-2006 – Synergies of national and European RTD activities. CREST 1211/1/01 Rev.1.

European Commission, 2001a; The Framework Programme and the European Research Area: application of article 169 and the networking of national programmes. COM (2001) 282 final.

European Commission, 2001b; Proposal for a Decision of the European Parliament and of the Council concerning the multi-annual Framework Programme 2002-2006 of the European Community for Research, Technological Development and Demonstration Activities aimed at contributing towards the Creation of the European Research Area. COM (2001) 94 final.

European Union, 1997; Consolidated Treaties, Treaty on European Union, Treaty establishing the European Community, Luxembourg: Office for Official Publications of the European Communities - 168 pp. ISBN 92Ü828Ü1640Ü0.

Funtowicz, S., 2001: Developing the practise of sustainable science; experiences beyond post-normal science. Presentation. Workshop "Setting concepts into motion: Sustainable Development and R&D policies – development of scientific tools in support of Sustainable Development decision making. Brussels, 28/29.10.2001.

Krott, M., 2001: Evaluation for Optimising Sustainable Development Research. Experiences from the Austrian Research Programme "Cultural Landscape Management". Presentation. Workshop "Setting concepts into motion: Sustainable Development and R&D policies – development of scientific tools in support of Sustainable Development decision making". Brussels, 28/29.10.2001.

Pichler, R., 2001; Workshop Note "Joint Programme on Sustainability under article 169 of the EC Treaty", Vienna Workshop, 14 December 2001, Federal Ministry of Transport, Innovation and Technology.

Weber, M., K. Whitelegg, 2001; National Research Activities and Sustainable Development. Presentation. Workshop "Setting concepts into motion: Sustainable Development and R&D policies – development of scientific tools in support of Sustainable Development decision making. Brussels, 28/29.10.2001.

Synthesis of Session 3
Scientific methodologies and tools for underpinning a Sustainable Development policy: how to go beyond

Ir. Matthieu Craye

Universiteit Antwerpen (UA-UFSIA)
Studiecentrum Technologie Energie en Milieu (STEM)
Kleine Kauwenberg 12, 2000 Antwerpen
Belgium
matthieu.craye@ua.ac.be

Introduction

The goal of the third session was to give an overview and classification of scientific methodologies and tools for underpinning a sustainable development policy. Experiences with these tools and examples of case studies were presented. The ultimate objective was to start a discussion on how to go beyond current practices in sustainability research.

In the first presentation of this session, P. Boulanger and T. Bréchet (Bréchet 2002), described the decision-making process and the need for relevant tools. This was based on a set of five criteria used to characterise sustainability issues.

P. Hardi (Hardi 2002) gave an overview of models and conceptual frameworks in the context of measurement tools.

D. Rossetti di Valdalbero (Rossetti 2002) presented research results on external costs of energy production and transportation activities as obtained by the ExternE project team.

F. Summer (Summer 2002) tackled the question whether indicators can make a difference for local policies for sustainability.

M. O'Connor (O'Connor 2002) presented tools to support deliberative procedures for the integrated management of underground water.

J. Eyckmans' talk (Eyckmans 2002) was about an inter-disciplinary research network on climate change, which had mathematical simulation models as its common research language.

Finally, R. Schleicher-Tappeser (Schleicher 2002) discussed a system for the management of sustainable development processes consisting of concepts, methods and internet-based tools.

In the following sections, we highlight some of the main elements for discussion that remain after the different presentations.

Questions about the policy relevance/impact of sustainability research.

The presentations made clear that there exists an impressive amount of research on sustainability issues.

However, serious doubts are expressed about the relevance and impact of this research. This was most clearly done by F. Summer, who, while investigating the role indicators currently play in local policies, came to the overriding conclusion that "indicators do not have a significant influence on decision-making processes in local governments".

And indeed, it is not difficult at all, to list some important sustainability issues, in which science can/tries (to) play a prominent role, but which show no or only very little "progress" (Craye 2001b). To mention a few:

- continuing debate and controversy with regard to possible environmental damage caused by the release of GMOs;
- increasingly congested traffic despite ozone alerts;
- the lack of adequate measures to curb the emission of greenhouse gases (some of the figures in Eyckmans' presentation suggest that the Kyoto scenario is very much a "business as usual" scenario!);
- a pile of radioactive waste but (as yet) no definite storage places;
- controversies over the health threats posed by the emission of pollutants, etc.

These topical issues suffice to call into question the effectiveness of current research and policy processes and their interactions/communication, when it comes to the questions of sustainable development.

In many of these cases, expert opinion as expressed by members of the scientific community, didn't lead to robust knowledge within the social and policy context. (Moreover, in some cases the expression of different scientific opinions intensified social controversies!)

Development and use of scientific tools within different views on policy and decision-making processes.

Pointing at these issues, "rational" scientists will often blame policy makers for not having the courage to take the "right" decisions, assuming these right decisions can be deducted more or less straightforward from the scientific data.

This reasoning is rooted in a linear, "rational actor" model of policy processes.

A lot of scientific work, i.e. the development of tools to support SD policy, takes such a model of the policy reality for granted.

The description of the decision-making process by Bréchet and Boulanger is in its essence also based on this "rationality" model. (decision making is best understood as a whole process consisting of identifying feasible actions, valuing and evaluating their likely consequences then selecting the most appropriate sequence of actions and monitoring their impact...).

Two remarks are at its place here:

1. this view on the decision making process is only one among others, even if it is widely accepted within the scientific community. The actual study of policy processes supports argumentation of the inadequacy of this model when it is used in the context of sustainable development.
2. such visions or models of policy processes are to be seen and interpreted as heuristics. They are in no way an accurate picture of how decision making actually proceeds. They offer a framework within which we can situate and interpret our actions in the policy context.

Although this remark seems very straightforward, to be fully aware of it could prevent policymakers and researchers to have unrealistic mutual expectations.

It is important to notice that the development and use of scientific expertise, is always – be it implicitly – embedded within a particular vision of political and societal processes.

With respect to sustainable development, one can roughly distinguish two "antagonistic" approaches of policy making (Craye 2001a): the one presented by Bréchet and Boulanger, which can be called a "blueprint approach" of sustainable development and another one, a "learning or development approach". The latter is best illustrated in O'Connor's paper.

When following a blueprint approach, one considers the concrete goals and objectives of sustainable development as known or as definable. Indicators are available or can be developed to check whether our societies develop in the direction of these goals. The blueprint approach stresses the need to implement and evaluate measures to reach the defined goals.

The learning approach leaves the idea of objectives defined in advance. Sustainable development in this approach means in the first place a strong and sustainable involvement of all societal actors while discussing plans and measures (the "governance" aspect of SD). This approach stresses the learning effects that processes of deliberation can produce. The confrontation of the different actors' visions and actions can lead to reflection and eventually reflexive rethinking of an actor's role and functioning. This in turn creates space for negotiation and for finding new common goals and strategies.

In the first approach scientific tools are conceived to offer "blueprints" to the policy actors (the goals to be achieved and a portfolio of measures to achieve these goals).

In the second approach tools should enhance the possibilities of reflexive discussion and deliberation.

When looking at the different presentations one can say that a "traditional use" of the models and measurement frameworks, of the external cost data, of indicators and of the climate change models reflect science's role within a blueprint approach.

The tools developed within the GOUVERNe project (O'Connor: "where a single method or principle of good water resource management does not prevail, a reasoned and robust base for regulation of resource use must have a reflexive deliberative character" and "an analyst in these circumstances needs to be like a midwife of problems, helping to raise into visibility, questions and issues towards which you can assume different positions, and with the evidence gathered and arguments built for and against these different positions"), the idea of managing the process of indicator development and use (F. Summer) and the SQM system (Schleicher-Tappeser : "SD is a useful concept that involves an open learning process, and that it makes no sense to give a detailed universal measurement rule for "sustainability"") are examples of science's role as stimulator of deliberation and learning.

This learning approach corresponds to the conception of sustainability research as "postnormal science" (Funtowicz and Ravetz 1992). This type of scientific practice seems more adequate in view of the main characteristic of sustainable development, namely complexity. It is presented as a reaction to the still dominant reasoning within a "normal science" framework in a context of inherent complexity and the difficulties thus encountered.

Different views on participation.

Although all presentations contain a plea for more and better efforts to communicate scientific work and for participation of stakeholders to knowledge and policy development, it is clear that not all speakers assign the same role to participation.

Scientific practice within a blueprint approach will have a very functional (in terms of acceptance of results) view of participation, while in the learning approach active involvement of concerned actors is the very heart of the postnormal science/policy practices.

Different treatment of uncertainties.

Besides participation, all of the presenters stressed that treatment of uncertainties is another future challenge for the scientific tools and instruments to be developed.

But also on this point, there is no consensus on how this challenge has to be taken up.

When reasoning within the blueprint approach, the quasi-automatic reaction towards uncertainty will be to mention it in an oblique way, and to present it as reducible. In this way inherent uncertainty, ignorance and indeterminacy (Wynne 1997) of knowledge are often masked by the precision with which scientific data are presented. By comparing different studies on environmental costs of energy technologies, Stirling criticised this "false precision" (Stirling 1999). According to Stirling, results obtained by such methods as external cost calculation are critically dependent on the assumptions you start from. In this way it makes no sense to present the results as mere precise numbers. He refers to the choice that has to be made as one between "accurate and approximate or precise and wrong".

An awareness of the fact that scientific information is only (if at all) taken up in the policy context in a conceptual way and not in an instrumental way, could convince scientists not to present their results without reference to contingencies and contextualities (Grin 1997).

On the other hand, the learning approach looks for ways to accommodate with uncertainty (O'Connor: "instead of reducing uncertainty as main goal: at stake, however is not the admission of partial ignorance but, rather, the significance to be attached to the forces of change being engaged under conditions of inability to exercise mastery over eventual outcomes").

On the basis of his research, Summer also comes to the conclusion that the importance of indicators lies not so much in the precise numbers of the right indicators ("To date most of the efforts are still concentrated on developing the right set of indicators. The research by Pastille has shown that in terms of influencing policymaking the management of indicators is more important than the indicators themselves....Indicators are not only about guiding decision makers. Indicators serve other purposes such as raising awareness about sustainability, creating a platform for debate and encourage learning between different stakeholder groups").

How to go beyond? Different "streams" in sustainability research.

Bréchet and Boulanger present two different toolkits that are necessary for rational decision making: one focusing mainly on the decision's maker side of the problem (what preferences? what values?) and another one to analyse what can be done with and on the target system, how it is likely to react to such and such decision…

It can be questioned whether in the context of a highly normative issue as sustainable development these two toolkits can be strictly separated, i.e. even the estimates of how a system will react upon a decision, are intertwined with normative assumptions. It is not surprising that in sustainability research a group of synthetic or integrated approaches emerged. (as Hardi phrases one of the lessons learnt from his research: "there is a general tendency in postnormal science to redefine characteristics of scientific inquiries. SD is a point in case, as it raises the need for considering co-evolutionary and participatory processes and equity/ethical considerations as inherent components of a new scientific inquiry.")

Future activities in sustainability research can be situated vis-à-vis following "traditions" or "streams".

Analytical approaches.

The methods used in formal decision science and environmental assessment are intended to evaluate policy options by means of economic, physical, and administrative criteria. If applied correctly, they exhibit scientific earnestness; where possible, they provide arguments based on the persuasive power of data.

Furthermore, tools have been developed in this tradition that allow one to present differences between expert opinions to the public in an understandable way (scenario building, multi-criteria analysis, Group Delphi…).

Deliberative approaches

These approaches explicitly recognise and honour the existence of different mental frames. The development in the Technology Assessment discipline towards participatory and interactive Technology Assessment (Grin 1997) is a good example in this respect. These approaches are a good way of looking for appropriate methods for making more explicit the arguments of the various actors involved regarding problem definitions, solutions, ways of thinking and deeper preferences. Gradually, through repeated confrontation, they can lead to an innovative synthesis offering new solutions.

Attempts to synthesis: participatory integrated approaches.

A synthesis of the two above traditions would imply a mutual enrichment of the social, policy and scientific discourse. It could lead to evaluations that integrate values and scientific knowledge and that are useful to policymakers. It could, for example, provide knowledge about more options, insight into the criteria that are relevant to decision-making, as well as insight into the source, the nature and the perception of uncertainties.

The purpose of a synthetic approach is then to provide a framework for learning processes as well as a systematic exploration of issues. Key concepts are therefore: transparency, scepticism, independence, responsibility; but also: a broadening of the approach, taking due account of alternative options, plurality of societal perspectives, recognition of uncertainty and ignorance, and taking into consideration the question of usefulness and merit.

In order to attain these goals, a list of relevant criteria that a synthesis must meet, can be drawn up (Craye 2001b):

- *Flexibility and a broad focus.*
  The approach and methods as such should not impose restrictions in terms of the kind of criteria and arguments that one wishes to use for the assessment of policy options.
- *Openness with regard to choices, values, mental frames and assumptions.*
  It should be possible to take account of a great variety of interests, values, priorities and assumptions. There should also be openness with regard to possible policy strategies and options.
- *Honesty with regard to uncertainty.*
  Uncertainties must be recognised and studied. The analysis must "explore" a wide range of possible outcomes.
- *Heuristic exploration rather than unusable precision.*
  The methods used should not be regarded as an "analytical fix" which itself determines a specific "rational" decision. They must also provide support for the acquisition of relevant knowledge and an exploration of policy strategies.
- *Analytical discipline and sincerity*
  The methods used must have an adequate theoretical basis. Their application must be systematic and verifiable.
- *Transparency in order to allow review*
  A form of audit must be possible in order to connect the results with different "inputs", assumptions and parameters.
- *Openness towards broad participation*
  The methods must allow an open, participatory and argumentative approach.
- *The possibility of incorporation into regulatory processes.*
  The requirements that methods impose must be "realisable", their implementation must not be excessively expensive. The dangers of ambiguity and non-robust results must be minimised.
- *Feedback, iteration, reflexivity*
  A successful approach to dealing with complex issues must allow learning processes, and thus provide feedback.
- *Stimulate multi-disciplinarity*
  The incorporation of different disciplines is necessary for dealing with such complex issues. The approach must enhance co-operation between these disciplines.

As a final remark, it can be stated with almost certainty that the plural visions on what sustainability is will always entail a plurality in methodologies. If one wants to go beyond, it's better to leave the goal and the idea of "the one right method" behind!

References

Craye 2001a
Craye M., Goorden L., Van Gelder S., Vandenabeele J., Milieu en gezondheid: naar een adequate dialoog tussen overheid, bevolking en wetenschap, Antwerpen, UFSIA-STEM, januari 2001, 149p.

Craye 2001b, PODO1I
Craye M., Goorden L., Van Gelder S., Besluitvorming inzake milieu : methoden en instrumenten, Brussel, DWTC, november 2001.

Eyckmans 2002
Eyckmans J., "The Climneg research network", paper presented at the workshop "Setting concepts into motion : sustainable development and R&D policies", OSTC/EC, Brussels, November 2001.

Funtowicz 1992
Funtowicz, S., J. Ravetz, Three types of risk assessment and the emergence of post-normal science, in : S. Krimsky & D. Golding (eds.), Social theories of risk, Praeger pubilshers, Westport, 1992.

Grin 1997
Grin J. et al, Interactieve Technology Assessment: Een eerste gids voor wie het wagen wil. Den Haag: Rathenau Instituut, 1997; W57.

Hardi 2002
Hardi P., "Challenges and limits of existing tools for underpinning an SD policy", paper presented at the workshop "Setting concepts into motion : sustainable development and R&D policies", OSTC/EC, Brussels, November 2001.

O'Connor 2002
O'Connor M., "Systems science and social significance – why stakeholder concertation is impossible, necessary and desirable for integrated water resource management", paper presented at the workshop "Setting concepts into motion : sustainable development and R&D policies", OSTC/EC, Brussels, November 2001.

Rossetto 2002
Rossetti di Valdalbero D., "Energy and transport : pricing externalities in the European Union", paper presented at the workshop "Setting concepts into motion : sustainable development and R&D policies", OSTC/EC, Brussels, November 2001.

Schleicher 2002
Schleicher-Tappeser R., "Problems and options in assessing sustainable development – the SQM approach and experiences in the context of structural funds.", paper presented at the workshop "Setting concepts into motion : sustainable development and R&D policies", OSTC/EC, Brussels, November 2001.

Stirling 1999
Stirling A. et al., On science and precaution in the management of technological risk. ESTO Project, Final Report, May 1999.

Summer 2002
Summer F., "Does measurement count ? Assessing the influence of sustainability indicators in policymaking", paper presented at the workshop "Setting concepts into motion : sustainable development and R&D policies", OSTC/EC, Brussels, November 2001.

Wynne 1997
Wynne, B., Methodology and institutions : value as seen from the risk field, in : J. Foster (ed.) , Valuing Nature ? Econmics, Ethics and Environment, Routledge, London/New York, 1997.

Summary, conclusions and future outlook. The link between the challenges and the possible steps forward.

Uno Svedin

Professor, Director of International Affairs,
Swedish Research Council for Environment,
Agricultural Science and Spatial Planning (Formas),
Box 1206, SE-111 87 Stockholm, Sweden
Uno Svedin@formas.se

Former Chair of The European Consultative Forum on the
Environment and Sustainable Development (June 2000-October 2001)

Can we achieve European added value by linking national programmes/activities and how should it be done?

Use different available mechanisms (not only article169)

- Discus separately:
    - "tools";
    - "mechanisms";
    - "frameworks";
- Use test cases.

Characteristics of test cases

- Scale;
- Progression in time (early steps);
- Single test case versus a combined set of cases (“portfolio”);
- Build on already ongoing activities;
- Right level of cooperation;
- Bottom up versus top down;
- Iterative approach;
- Early relationship to broad user consituencies. Create participatory mechanisms in the overall proces-design.

Thematic examples

- European land use, food production, biodiversity;
- Climate change and energy technology R&D outlook;
- European fisheries policy in relation to ecosystem management;
- Urban transport systems and infrastructure development.

Next steps

- identify a small set of lead topics;
- connect them to tools;
- "warm up" activities;
- make packages, but use “variable geometry” (I allow for many different forms);
- use small voluntary core groups for different avant guard activities.

The Science Policy relation - bridging the gap

- there is a gap;
- understand the differences in the “logic” of the two sides;
- appreciate a common task;
- find practical means and institutional forms to face the challenges ;

Comments

Pierre Valette

Head of Unit

Directorate General for Research, European Commission
200 Rue de la Loi, B - 1049 Brussels, Belgium
Pierre.Valette@cec.eu.int

Questions about article 169 raised during the workshop

- A "national programme" could be defined as a specific programme of a Member State implementing; for example, its activities by call for proposals (as in Germany).
- Article 169 is defined as a programme executed by different Member States according to the Treaty. The Commission should not be involved with project or programme management of an article 169. Indeed the Commission's involvement in an article 169 is lower than for the other instruments.
- The creation of an "ad hoc" organism for the management of the project could be envisaged. The funding resources (national and EU) would be allocated to this organism.
- The EC budget for article 169 should be "top-up" money and not replacement money.
- The budget necessary for an article 169 will not be additional money to the budget of a priority/sub-priority, but just one of the implementing modes of this priority/sub-priority and that within its budget.
- Reference to implemented article 169 implemented should be made during the development of work programmes of the different priorities
- A research project on Sustainable Development, which is not covered by article 169, could be implemented by other instruments.
- The Commission will be in charge of preparing the "Council and Parliament decisions" for each political article 169 project on the basis of a spontaneous proposal coming from "groups" of Member States. This document should state explicitly from which part (priority, sub-priority, theme) of the Framework Programme should be taken the Community contribution and also the exact amount of this contribution. To the question if the budget for an Article 169 could come from more than one budgetary line, the reply was positive although there is a potential difficulty in implementation.

Progress in the discussion about article 169

There are two categories of elements necessary to make concrete progress in the discussion about article 169. They are relative to:

- Additional practical information about the implementation of article 169, including the way to introduce an activity in the framework of this article.
- An example of concrete activity which could be subject of article 169, in the time suggested by C. Patermann, and completed by a "real case" as it was suggested by some speakers during the meeting (Mr. Ziegler and Svedin in particular).

Of course, we cannot dissociate the discussion of article 169 from the other opportunities offered by the new Framework Programme. New Instruments and Co-ordination activities offer also opportunities for a close co-operation between Member States to work on Sustainable Development. We have to judge, in this context, if article 169 "makes the difference" for achieving in the most cost-effective way the objectives of Göteborg concerning Sustainable Development.

Possible subjects for article 169 on Sustainable Development

Motivation

Subjects for article 169 should be precisely specified and correspond to well-defined national research activities. This last consideration means that national public funds would be able to cover explicitly the activity described in the work programme subject to article 169. Of course, the subject was to be also explicit in the Framework programme activity.

As far as the Sustainable Development is concerned and in terms of substance, the subject which would be considered for article 169 would be relative to the development of methodological approaches, tools, indicators and criteria necessary for the Sustainability policy definition and monitoring on one side, for the Sustainability Impact Assessment, on the other side. This last concept has been announced in Göteborg and in Laeken and it becomes an instrument of evaluation of policies and measures or options implemented for achieving the Sustainable Development objectives; this instrument should ensure also consistency between policies.

A "real test case" would be also addressed (e.g. sustainable utilisation of agricultural resources); it would correspond to a field of application of the methodologies, indicators and criteria developed in the framework of the first area. The "real test case" would have to be included in the priorities of both Göteborg and the 6th Framework Programme (priority 6 "Sustainable Development, Global Change and ecosystems").

These activities would be completed by a "best practices" exchange, including the possibility of their transferability.

This proposal corresponds to a common need of Member States and the EU. It would produce common methodologies and tools based on the same classifications and definitions of variables, indicators and criteria; these methodologies and tools would be similar from one country to another country from the beginning and international comparisons of results would be feasible; furthermore these methodologies and tools would have been tested on a sensitive "real case" representing a common issue to all the countries.

Methodologies, Indicators and Criteria

The main objectives which would be assigned to this activity is to develop tools in support to Sustainable Development policies and measures, including their monitoring and their assessment, tools in support of Research policy in the context of Sustainable Development would be taken into consideration.

Three categories of tools would be developed for Sustainable Development policies and measures:

- Building of "accounting frameworks" of positive and negative externalities associated to technologies, policies and measures implemented in the framework of a Sustainable Development strategy; application of these "accounting frameworks" to the elaboration of the "green accounting" of GDP.
- Development of assessment tools and decision support tools; tools include mathematical tools (nuclear statistical analysis), models for forecasting and impact analysis (like E3 models), conceptual environment and socio-economic frameworks in the context of measurement and assessment, development of indicators and indices that capture element of S.D. (including their linkage), common data sources (economic and social, scientific, techno-economic) for tools, treatment of uncertainty and risk assessment (for Precautionary Principle application), tools for multi-criteria analysis.
- Development of tools for Research policies: conceptual framework for definition of new programmes and selection of projects (criteria and indices); tools for monitoring the research.

"Real Case"

The main objective for this part is to provide a better understanding of the Sustainable Development problems of specific sensitive issues in the 3-dimensional context of Sustainable Development and in a local/regional/ European context, not forgetting that the EU is part of a world wide economic/social and environmental system.

Different "Real Cases" have been suggested: land use, production systems for agriculture, biodiversity, integrated fisheries policy, integrated forest management, transportation modes substitution, environment and health (chemical products), energy resources.

One test case would be selected and the methodologies defined above would be applied to this case for demonstration.

Best practices exchange

Information on "test practices" implemented in the countries at national, regional or local levels would be exchanged on a systematic basis according to the methodologies and the "real case" defined above.

Comments

P. Sørup

Head of Technologies for Sustainable Development Unit

European Commission – Joint Research Centre
IPTS - Institute for Prospective Technological Studies
Edificio World Trade Centre - c/Inca Garcilaso s/n
E – 41092 Sevilla - Spain
Per Sørup @jrc.es

Following two days of intense discussions, it is only possible to draw some preliminary conclusions from the great number of interesting interventions and debate sessions.

Very briefly, it seems worth highlighting the following:

- The first step is that of identifying relevant topics of research;
- The second step is that of defining or characterising such topics by identifying key actors, relevant time-horizons, and the level at which each topic is of relevance;
- The third step is that of identifying the most suitable case-specific instrument to carry research in support of Sustainable Development further in each identified relevant topic.

Possibly, due to the pending introduction of interesting new instruments for collaboration in the 6th RTD Framework Programme, the focus of discussions during the workshop has been somewhat skewed towards the "instruments" while leaving in the shadow a more detailed definition of the "topics" to be tackled.

It is worth highlighting that the 6th RTD Framework Programme includes a range of instruments suitable to different collaboration patterns (sharing of information), different formal procedures and different research requirements:

- Networks of excellence
- Integrated projects
- Joint national programmes with Community participation
- Specific targeted research projects
- Co-ordination activities
- Specific activities covering new fields.

The implementation of the 6th RTD Framework Programme may give rise to a number of collaborative patterns, including:

- Supplementary programmes (article. 168 of the EU Treaty)
- Community participation in R&D programmes initiated by several Member States (article 169 of the EU Treaty)
- Joint undertakings (article 171 of the EU Treaty)
- Co-operation with third countries/ international organisations.

For the sake of coherence and consistency, I will try to summarise here the topics having emerged from the two-day discussion in the framework of the characterisation of R&D in support of the EU Sustainable Development Strategy made at the workshop's opening session.

As far as "systemic research" is concerned, attention should focus on transferability matters, namely on:

– What constitutes policy-relevant pan-European researchable SD scenarios, and;
- What should policy-relevant R&D focus on, embrace, aim at, etc.

The "problem-solving" characteristic, discussions led to the emergence of the following sectors/ topics: **What is "article 169" and why could it be interesting for sustainability research?**

- EU sustainable climate change policy (and global governance);
- EU sustainable land use (integrated ecosystems planning and management);
- EU sustainable fishery and agriculture policy (balanced approach to economic aspects, natural resources management, health);
- EU sustainable integrated product policy (IPP) and consumption patterns;
- EU policies striving to achieve a sustainable transport system.

When discussing tools and in line with the presentation on Day 1, it seems worthwhile maintaining a clear distinction between tools for sustainable development policies and tools for research policies supporting sustainable development. Following discussions with workshop participants, the overall impression is that this distinction is in fact not only useful but also crucial to tackle two different areas of activity.

In the first area – tools for sustainable development policies – the development of integrated assessment tools and decision support systems via appropriate new or newly organised sets of indicators seems to represent a common requirement at both the national and the EU level.

In the second area – tools for research policies supporting sustainable development – the following issues have been outlined as being of common interest to representatives of Member States and Commission services, namely:

- Detailed mapping and exchange of experience in R&D programmes supporting sustainable development;
- Development of relevant selection criteria for integrated R&D programmes and activities supporting sustainable development;
- Creation of incentives for scientists and researchers to contribute pro-actively to R&D programmes and activities supporting sustainable development.

To conclude the workshop organised at the IPTS' premises in Seville in spring 2002 will tackle these issues and will allow sound discussions on experience exchange and collaboration based on the final results of the mapping exercise currently being finalised by the IPTS and the ESTO network.

Once more, I would like to conclude by thanking the workshop organisers as well as my collaborators, Mr Luís Delgado, Mr Fabio Leone, Mrs Laura Lonza, and Ms Laura Tapias, for their on-going support.

Setting concepts into motion:
Sustainable Development and R&D policies

Development of scientific tools in support of Sustainable Development decision making

Workshop – Brussels
Hotel Astoria
28 – 29 November 2001

Programme

28 November 2001

Policy instruments for Sustainable Development research

The first day focuses on **research policy instruments** for Sustainable Development. It is designed to present and discuss the impact of the latest EU policy papers on Sustainable Development (research), EU research instruments (next Framework Programme, article 169), to present national activities (IPTS study) with regard to Sustainable Development research and analyse their results and experiences. Particular attention is given to article 169 as an instrument and to potential topics in the area of Sustainable Development to be implemented by article 169.

09.00 Welcome coffee

Session 1
Chair: *Nicole Henry (OSTC, Head of the Research Department)*
Rapporteur: *Renate Loskill (BMBF-PT-J, G)*

10.00 Welcome by Eng. Eric Beka, Secretary General of the OSTC, presented by *Nicole Henry (OSTC, Head of the Research Department)*

10.05 Message of Yvan Ylieff, Government Commissioner, attached to the Minister for Scientific Research presented by *Jacques Wisenberg (Advisor of the Government Commissioner)*

Future
10.15 Welcome by the European Commission
Sustainable Development research - Opportunities and perspectives under the next framework programme (2002-2006), including article 169;
Christian Patermann (Director, DG RESEARCH, European Commission)

Strategy
10.35 Sustainable Development and R&D policy – the European context
Uno Svedin (Formas, Former Chair European Consultative Forum on Environment and Sustainable Development, S)
- Conclusions extracted from the meetings in Amsterdam, Stockholm and Göteborg and from the (World) Forum on Sustainable Development;
- Sustainable Development research implications as stated by the Commissions strategy paper on Sustainable Development and the Göteborg meeting;
- Challenges and perspectives.

10.50 Implications for Sustainable Development research from the White Paper on European Governance
Angela Liberatore (DG RESEARCH, European Commission)

11.00 Conclusions extracted from the Bonn Meeting, evolution since and introduction to the Seville Meeting. - *Per Sørup (Head of Unit, IPTS/JRC, European Commission)*

Present
11.10 "Acquis" under the EU research Framework Programme in the context of the Göteborg conclusions
Pierre Valette (Head of Unit, DG RESEARCH, European Commission)

11.35 Discussion round on these topics

12.30 Lunch

Session 2
Chair: *Esteban Manrique (Oficina de Ciencia y Technologia, Es)*
Rapporteur: *Andreas Geisler (Ministry for Science and Transport, AU)*

14.00 IPTS survey and assessment of a study on national Sustainable Development research initiatives in support of national and EU Sustainable Development policies
Matthias Weber (Department Technology Policy at Austrian Research Centres)

- Identify and review national research activities addressing the threats to Sustainable Development identified in the EU strategy and in the Göteborg Council;
- Comparison of detailed activities in a number of EU countries;
- Analyse and compare good practices (including evaluation) and gaps in current research initiatives;
- Perspectives for establishing a European sustainability research forum (REDESUD);
- Map key players in Sustainable Development in selected countries as an input to future network building at European level.

14.20 Experiences from the Austrian research programme “Cultural landscape management”
Max Krott (University Göttingen, KLF Programme (A))
Extract the experiences from a finishing 10-year programme about scientific tools for Sustainable Development and the challenges of inter- and trans-disciplinarity and (project-programme) evaluation

14.40 Developing the practise of sustainable science, experiences beyond post-normal science
Silvio Funtowicz (IPSC/JRC, European Commission)
Discuss the shift in science: from normal science to post-normal science. This shift takes into account complexity, the role of stakeholders etc. A lot of these characteristics are also relevant with respect to sustainability research. How can these characteristics of "sustainability" (a/o. the three pillars) be integrated into research programming/organisation?

15.00 Coffee

15.30 - 18.00 *Tour de table* and discussion round
Priority research areas and suited instruments, issues for European networking... Introduction of the discussion by the rapporteurs from both half days and the Chair. The need for future Sustainable Development research in regard to European policies, in particular Sustainable Development – reflection of the situation in the countries: what are the priority areas? Which instruments (research organisation, selection and evaluation procedures) are best suited.

- Do all countries have national research activities that could be co-ordinated?
- How can a better co-ordination of national programmes/policies be achieved (ERA)? How can a European Network of Excellence be best achieved?
- Is article 169 a well-suited instrument for Sustainable Development research? How can article 169 be successfully put to use.

29 November 2001

Scientific methodologies and tools for underpinning a Sustainable Development policy: how to go beyond

The second day focuses on **scientific methodologies and tools** for underpinning a Sustainable Development **policy**, which deal with economic, social and environmental policies in a mutually reinforcing way in the context of e.g. sustainable impact assessment.
It provides an overview and classification of various existing tools used in Sustainable Development research, experiences with and usefulness of these tools and examples of case studies that have implemented and/or developed tools. The final discussion round focuses on the need for further research in this context, how to go beyond!

Session 3
Chair: *Henryk Sobczuk (Inst. Environmental Protection Engineering, Lublin, Po)*
Rapporteur: *Matthieu Craye (UFSIA, STEM, B)*

9.00 Overview/classification/characteristics of scientific tools for Sustainable Development research – European and global approaches
T. Bréchet, P.-M. Boulanger (IDD, B)
Provides an overview on existing tools and their characteristics (benchmarking, good practices, assessment tools, LCA, integrated assessment modelling, participatory approach, internalisation of external costs, monitoring and measuring, indicators, etc.) to support Sustainable Development decision making and to evaluate the efficiency of decisions

09.40 Challenges and limits of existing tools – how to go beyond.
Peter Hardi (IISD, Canada)
This presentation will be closely linked/complementary to the previous one and will discuss experiences with various tools, emphasising the usefulness of various types of indicators. How to go beyond – the speaker will provide information on potential future frameworks and needs for tools in regard to Sustainable Development research and decision making.

10.00 Coffee

Presentation of case studies/projects that will address their experiences with various tools (*20 min time is reserved for each presentation).*
Speakers will be provided with clear guidelines on what questions to address from their projects. The objective of these presentations is not to present the research per se, but to extract its usefulness for Sustainable Development decision making, e.g. to address identified characteristics of Sustainable Development R&D (e.g. inter- and trans-disciplinarity and complexity, long-term goals, precautionary principle, participatory approaches, global dimension) and to show potential future ways on: how to go beyond.

10.20 Energy and Transport: pricing externalities: EESD project ExternE
Domenico Rossetti di Valdalbero (DG RESEARCH, European Commission)

10.40 Promoting Action for Sustainability through indicators at the local level in Europe – PASTILLE
Florian Sommer (London School of Economics and Political Science - Department of Geography, UK)

11.00 Management of natural resources - GOUVERNe: develops a system for a sustainable exploitation of underground water, taking account of the different actors (decision-makers, stakeholders…)
Martin O'Connor (Université de Versailles, F)

11.20 Climate Change: CLIMate NEGotiations
Johan Eyckmans (dept. Economie, KULeuven, B)

11.40 Problems and options in assessing Sustainable Development – the SQM approach and experiences in the context of structural funds - consequences for research
Ruggero Schleicher-Tappeser (EURES - Institut für regionale Studien in Europa KG, G)

12.00 Questions and comments

12.30 Lunch

Session 4
Chair: *Hansvolker Ziegler (BMBF, G)*

13.30 Synthesis morning session
Matthieu Craye (UFSIA, STEM, B)

13.45 Synthesis of session 10 October AM
Renate Loskill (BMBF-PT-J, G)

14.00 Synthesis of session 10 October PM
Andreas Geisler (Ministry for Science and Transport, A)

14.15 Tour de table and discussion round
Will address:

- Discussion on - and set-up of a list of priorities of needed actions in Sustainable Development research in response to the debate on EU policies (day 1) and country activities in order to streamline activities
- Discussion on presented tools – what are priority issues in research and what barriers need to be overcome
- Second round of discussion on a potential Network of Excellence/use of article 169 in this field

15.15 Conclusions and summary of results of both days and future outlook - the link between the challenges (day 1) and the possible steps forward (day 2)
Final rapporteur: Uno Svedin (FORMAS, Former Chair European consultative forum on environment and Sustainable Development, S)

15.30 Reflections/comments by the Commission on the conclusions
Pierre Valette (Head of Unit, DG RESEARCH, European Commission) and
Per Sørup (IPTS/JRC, Head of Unit IPTS, European Commission)

16.00 Closing

Setting concepts into motion:
Sustainable Development and R&D policies –

Development of scientific tools in support of
Sustainable Development decision making

Workshop – Brussels
Hotel Astoria
28 – 29 November 2001

List of participants

Ioannis Anastasiou
European Commission
DG RTD / G-1, MO 75, 6/17
200, rue de la loi
1049 BRUSSELS
Belgium
Tel: +32/2/295.97.78
Fax: +32/2/299.49.91
Email: ioannis.anastasiou@cec.eu.int

Dr Andris Andrushaitis
Institute of Aquatic Ecology - University of Latvia
3 Miera Str.
2169 SALASPILS
Latvia
Tel: +371/294.54.05
Fax: +371/294.54.42
Email: andris@hydro.edu.lv

Dr Danuta Maria Antosiewicz
Institute of Fundamental Technological Research
ul. Swietokrzyska 21
00-049 WARSAW
Poland
Tel: +4822/826.25.02
Fax: +4822/828.53.70
Email: dantosi@ippt.gov.pl

Dr Mogens Bahn
National Environmental Research Institute
Frederiksborgvej 399
4000 ROSKILDE
Denmark
Tel: +45/46/30.13.30
Fax: +45/46/30.13.01
Email: mb@dmu.dk

Mr Tom Bauler
Université Libre de Bruxelles
Centre d'Etudes du Développement Durable – CEDD
(IGEAT-CEDD) CP 130/02
Avenue F.D. Roosevelt 50
1050 BRUSSELS
Belgium
Tel: +32/2/650.49.24
Fax: +32/2/650.43.12
Email: tbauler@ulb.ac.be

Mrs Marie-Carmen Bex
Federal office for scientific, technical and cultural affairs
Wetenschapsstraat 8
1000 BRUSSELS
Belgium
Tel: +32/2/238.34.81
Fax: +32/2/230.59.12
Email: bexm@belspo.be

Mrs Monique Blanken
Federal office for scientific, technical and cultural affairs
Wetenschapsstraat 8
1000 BRUSSELS
Belgium
Tel: +32/2/238.35.57
Fax: +32/2/230.59.12
Email: blan@belspo.be

Dr Paul-Marie Boulanger
Institut de Développement Durable
7, Rue des Fusillés
1340 OTTIGNIES
Belgium
Tel: +32/10/41.73.01
Fax: +32/10/41.36.49
Email: idd@euronet.be

Prof. Thierry Bréchet
Institut de Développement Durable
7, Rue des Fusillés
1340 OTTIGNIES
Belgium
Tel: +32/10/41.73.01
Fax: +32/10/41.36.49
Email: brechet@core.ucl.ac.be

Dr Eduardas Budrys
Institute of Ecology, NCP for Environment
Akademijos 2
2600 VILNIUS
Lithuania
Tel: +370/272.92.64
Fax: +370/272.92.57
Email: Ebudrys@ekoi.lt

Dr Jan Byman
Swedish Environmental Protection Agency
Blekholmsterrassen 36
SE-106 48 STOCKHOLM
Sweden
Tel: +46/8/698.15.70
Fax: +46/8/698.16.64
Email: jan.byman@environ.se

Mr Mario Catizzone
European Commission
Visiting Scientist at Naturvardsverket
Blekholmsterrassen 36
SE-106 48 STOCKHOLM
Sweden
Tel: +46/8/698.16.56
Fax: +46/8/698.16.64
Email: mario.catizzone@environ.se

Ir. Matthieu Craye
Universiteit Antwerpen (UA-UFSIA)
Studiecentrum Technologie Energie en Milieu (STEM)
Kleine Kauwenberg 12
2000 ANTWERPEN
Belgium
Tel: +32/3/220.49.10
Fax: +32/3/220.49.01
Email: matthieu.craye@ua.ac.be

Dr Arwyn Davies
EU and International Science Branch / EPINT
DEFRA -3/G27 Ashdown House
123 Victoria Street
SW1E 6DE LONDON
United Kingdom
Tel: +44/207/944.52.71
Fax: +44/207/944.44.20
Email: arwyn.davies@defra.gsi.gov.uk

Mr Jan De Smedt
Federale Raad voor Duurzame Ontwikkeling
rue des Aduatiques 71-75
1040 BRUSSELS
Belgium
Tel: +32/2/743.31.50
Fax: +32/2/743.31.59
Email: Jan.DeSmedt@frdo-cfdd.be

Mr Carlos Garcia Delgado
CDTI
Calle Cid 4
28001 MADRID
Spain
Tel: +34/91/581.55.62
Fax: +34/91/581.55.86
Email: cgd@cdti.es

Mr Luis Delgado
CEC - IPTS/JRC
Edificio Expo-W.T.C.
C/Inca Garcilaso, s/n
41092 SEVILLA
Spain
Tel: +34/954/488.405
Fax: +34/954/488.235
Email: luis.delgado@jrc.es

Mr Marc Depoortere
Conseil fédéral du développement durable
rue des Aduatiques 71-75
1040 BRUSSELS
Belgium
Tel: +32/2/743.31.50
Fax: +32/2/743.31.59
Email: marc.depoortere@frdo-cfdd.be

Mrs Loraine Fegan
Environmental Protection Agency
St. Martin's House – Waterloo Road
4 DUBLIN
Ireland
Tel: +353/1/667.44.74
Fax: +353/1/660.58.48
Email: l.fegan@epa.ie

Mrs Irene Gabriël
CEC – DG Research SDME D1 (7/80)
Square de Meeûs 8
1050 BRUSSELS
Belgium
Tel: +32/2/296.99.95
Fax: +32/2/296.30.24
Email: irene.gabriel@cec.eu.int

Mrs Anne Depauw
Federal office for scientific, technical and cultural affairs
Wetenschapsstraat 8
1000 BRUSSELS
Belgium
Tel: +32/2/238.34.62
Fax: +32/2/230.59.12
Email: depa@belspo.be

Dr Johan Eyckmans
Postdoctoral Fellow of the Fund for Scientific Research Flanders FWO
Katholieke Universiteit Leuven
Centrum voor Economische Studiën
Naamsestraat 69
3000 LEUVEN
Belgium
Tel: +32/16/32.68.44
Fax: +32/16/32.69.10
Email: Johan.Eyckmans@econ.kuleuven.ac.be

Mr Silvio Funtowicz
Institute for the Protection and Security of the Citizen (IPSC)
European Commission / Joint Research Centre
TP 650
21020 ISPRA (VARESE)
Italy
Tel: +39/0332/78.59.34
Fax: +39/0332/78.93.94
Email: silvio.funtowicz@jrc.it

Mr Bertrand Galtier
Ministère de l'Aménagement du Territoire et de l'Environnement (MATE)
Avenue de Ségur 20
75302 PARIS Cedex 07
France
Tel: +33/1/42.19.17.51
Fax: +33/1/42.19.17.71
Email: bertrand.galtier@environnement.gouv.fr

Mag. Andreas Geisler
Federal Ministry of Education, Science and Culture
Department of Environmental Sciences VI/A/4
Rosengasse 4
1014 WIEN
Austria
Tel: +43/1/531.20.71.53
Fax: +43/1/531.20.62.05
Email: andreas.geisler@bmbwk.gv.at

Dr Ales Gnamus
Counsellor to the Government
NCP 'Energy, Environment and Sustainable Development'
Ministry of Education, Science and Sport
Trg OF 13
1000 LJUBLJANA
Slovenia
Tel: +386/1/478.46.80
Fax: +386/1/478.47.19
Email: ales.gnamus@gov.si

Mr Alexander Grablowitz
Federal Ministry of Education and Research (BMBF)
Heinemannstrasse 2
53175 BONN
Germany
Tel: +49/228/57.38.87
Fax: +49/1888/57.838.87
Email: alexander.grablowitz@bmbf.bund.de

Mr Peringe Grennfelt
Swedish Environmental Research Institute
P.O. Box 47086
402 58 GÖTEBORG
Sweden
Tel: +46/31/725.62.34
Fax: +46/31/725.62.90
Email: peringe.grennfelt@ivl.se

Mr Joos Gysen
HIVA / Platform 'Indicatoren voor Duurzame Ontwikkeling'
Kapucijnenvoer 33, Blok H
3000 LEUVEN
Belgium
Tel: +32/16/33.20.88
Fax: +32/16/33.20.76
Email: joos.gysen@hiva.kuleuven.ac.be

Ms Jenny Hamilton
Scotland and Northern Ireland Forum for Environmental Research (SNIFFER)
11/13 Cumberland Street
EDINBURGH EH3 6RT
Scotland
Tel: +44/131/524.97.44
Fax: +44/131/652.36.15
Email: jenny@sniffer.org.uk

Prof. Peter Hardi
International Institute for Sustainable Development
161 Portage Avenue East, 6th Floor
R3B 0Y4 Winnipeg Manitoba
Canada
Tel: +1/204/958.77.31
Fax: +1/204/958.77.10
Email: phardi@iisd.ca

Mrs Nicole Henry
Federal Office for scientific, technical and cultural affairs
Head Dept. Research programmes
Wetenschapsstraat 8
1000 BRUSSELS
Belgium
Tel: +32/2/238.35.07
Fax: +32/2/230.59.12
Email: henr@belspo.be

Mr Luc Hens
Federale Raad voor Duurzame Ontwikkeling
rue des Aduatiques 71-75
1040 BRUSSELS
Belgium
Tel: +32/2/743.31.50
Fax: +32/2/743.31.59
Email: luc.hens2@pandora.be

Dr Rudy Herman
Ministerie Vlaamse Gemeenschap
Afdeling Technologie en Innovatie
Boudewijnlaan 30
1000 BRUSSELS
Belgium
Tel: +32/2/553.60.01
Fax: +32/2/553.59.81
Email: rudy.herman@wim.vlaanderen.be

Mrs. Bettina-Johanna Krings
Research Center Karlsruhe
Institute for Technology Assessmentand Systems Analysis (ITAS)
P.O. Box 3640
76021 KARLSRUHE
Germany
Tel: +49/7247/82.63.47
Fax: +49/7247/82.48.06
Email: krings@itas.fzk.de

Prof.DI Dr. Max Krott
Institute for Forest Policy and Nature Conservation
Georg August-Universität Göttingen
Büsgenweg 3
37077 GÖTTINGEN
Germany
Tel: +49/551/39.34.12
Fax: +49/551/39.34.15
Email: mkrott@gwdg.de

Mr Fabio Leone
CEC - IPTS/JRC
Edificio Expo-W.T.C.
C/Inca Garcilaso, s/n
41092 SEVILLA
Spain
Tel: +34/954/488.405
Fax: +34/954/488.235
Email: Fabio.Leone@jrc.es

Mrs Angela Liberatore
CEC - DG Research
Unit K3: Socio-economic Knowledge base
200, rue de la Loi – SDME 04/55
1049 BRUSSELS
Belgium
Tel: +32/2/295.22.29
Fax: +32/2/296.21.37
Email: Angela.Liberatore@cec.eu.int

Mr Oliver Lindqist
Centre for Environment and Sustainability
Göteborg University and Chalmers University of Technology
412 96 GÖTEBORG
Sweden
Tel: +46/31/772.28.62
Fax: +46/31/772.28.45
Email: oliver@inoc.chalmers.se

Mrs Laura Lonza
CEC - IPTS/JRC
Edificio Expo-W.T.C.
C/Inca Garcilaso, s/n
41092 SEVILLA
Spain
Tel: +34/954/488.405
Fax: +34/954/488.235
Email: Laura.Lonza@jrc.es

Dr Renate Loskill
Projektträger Jülich im Forschungszentrum Jülich GmbH
52425 JÜLICH
Germany
Tel: +49/228/57.32.07
Fax: +49/228/57.36.01
Email: r.loskill@fz-juelich.de

Mr Jean-Paul Malingreau
CEC - JRC
200, rue de la Loi - SDME 10/85
1049 BRUSSELS
Belgium
Tel: +32/2/296.94.33
Fax: +32/2/295.01.46
Email: jean-paul.malingreau@cec.eu.int

Dr Esteban Manrique Reol
Ministerio de Ciencia y Tecnología
Rosario Pino 14-16
28071 MADRID
Spain
Tel: +34/913/942.046
Fax: +34/913/941.774
Email: emanri@farm.ucm.es

Dott. G.M.R. Manzella
ENEA - Centro Ricerche Ambiente Marino (CRAM)
Forte S. Teresa-Loc Pozzuolo
P.O. Box 224
19100 LA SPEZIA
Italia
Tel: +39/0187/97.82.15
Fax: +39/0187/97.82.73
Email: manzella@santateresa.enea.it

Martin O'Connor
Professor of Economic Sciences - C3ED
Université de Versailles – Saint Quentin en Yvelines
47, boulevard Vauban
78047 GUYANCOURT Cedex
France
Tel: +33/1/34.61.09.75
Fax: +33/1/34.61.46.63
Email: Martin.OConnor@c3ed.uvsq.fr

Dr. Robert Oger
Centre de Recherches Agronomiques
rue de Liroux 9
5030 GEMBLOUX
Belgium
Tel: +32/81/62.65.78
Fax: +32/81/62.65.59
Email: oger@cragx.fgov.be

Dr Panos Papagiannakopoulos
Laboratory of Photochemistry and Kinetics (LAPKIN)
Departement of chemistry
University of Crete
71409 HERAKLION
Greece
Tel: +30/81/39.36.31
Fax: +30/81/39.36.01
Email: panosp@chemistry.uoc.gr

Mr Costas Papastavros
NCP for Cyprus for "Environment & Sustainable Development" of the 5th Framework Programme
P.O. Box 27510
2430 NICOSIA
Cyprus
Tel: +357/22/35.55.60
Fax: +357/22/35.56.22
Email: cy.fp5.environment@cytanet.com.cy

Dr Evangelos Papathanassiou
National Centre for Marine Research
Institute of Oceanography
Agios Kosmas, Hellinikon
16604 ATHENS
Greece
Tel: +30/1/965.35.20
Fax: +30/1/965.35.22
Email: vpapath@fl.ncmr.gr

Mr Christian Patermann
CEC - DG Research
Square de Meeûs 8
1050 BRUSSELS
Belgium
Tel: +32/2/295.18.15
Fax: +32/2/295.20.97
Email: Chris.Patermann@cec.eu.int

Dr Jonathan Radcliffe
Department for Environment, Food and Rural Affairs
3/G27 Ashdown House
123, Victoria Street
SW1E 6DE LONDON
United Kingdom
Tel: +44/207/944.50.35
Fax: +44/207/944.44.20
Email: jonathan_radcliffe@detr.gsi.gov.uk

Mrs Helena Ramos
Ministere de Sciences et Technologie (ICCTI)
R. Castillho 5-4°
1250-066 LISBOA
Portugal
Tel: +351/1/358.53.22
Fax: +351/1/315.40.65
Email: helena.ramos@iccti.mct.pt

Mr Michael Rantil
The Swedish Research Council for Environment Agriculture Sciences and Spatial Planning
Box 1206
SE-111 82 STOCKHOLM
Sweden
Tel: +46/8/775.40.67
Fax: +46/8/775.40.10
Email: michael.rantil@formas.se

Dr Jaana Roos
The Academy of Finland
P.O. Box 99
FIN-00501 HELSINKI
Finland
Tel: +358/9/774.883.38
Fax: +358/9/774.883.95
Email: jaana.roos@aka.fi

Mr Domenico Rossetti di Valdalbero
CEC - DG Research
Improvement of energy efficiency, MO 75 7/1
200, rue de la Loi
1049 BRUSSELS
Belgium
Tel: +32/2/296.28.11
Fax: +32/2/299.49.91
Email: domenico.rossetti-di-valdalbero@cec.eu.int

Mr Gunnar Sandberg
The Swedish EU R&D Council
Head of Office, NCP for QoL
Rue du Trône 98
1050 BRUSSELS
Sweden
Tel: +32/2/549.09.94
Fax: +32/2/512.99.43
Email: gunnar@eufou.se

Mr Ruggero Schleicher-Tappeser
EURES
Institut für regionale Studien in Europa KG
Basler Strasse 19
79100 FREIBURG
Germany
Tel: +49/761/70.44.1-15
Fax: +49/761/70.44.1-44
Email: r.schleicher@eures.de

Dr Henryk Sobczuk
Technical University of Lublin
Institute of Environmental Protection Engineering
ul. Wapienna 40B
20-502 LUBLIN
Poland
Tel: +48/81/538.14.13
Fax: +48/81/525.41.24
Email: henryk@gaja.ipan.lublin.pl

Mr Florian Sommer
Pastille Project
New Economics Foundation
Cinnamon House
6-8 Cole Street
LONDON SE1 4YH
United Kingdom
Tel: +44/207/089.28.39
Fax: +44/207/407.64.73
Email: florian.sommer@neweconomics.org

Dr Per Sørup
CEC - IPTS/JRC
Edificio Expo-W.T.C.
C/Inca Garcilaso, s/n
41092 SEVILLA
Spain
Tel: +34/954/488.405
Fax: +34/954/488.235
Email: per.sørup@jrc.es

Prof. Isabel Sousa Pinto
Centro Interdisciplinar de Investgação Marinha e Ambiental
Rua do Camp Alegre 823
4150-180 PORTO CEDEX
Portugal
Tel: +351/22/608.04.78
Fax: +351/22/606.04.23
Email: ispinto@cimar.org

Prof. Uno Svedin
The Swedish Research Council for Environment
Agricultural Sciences and Spatial Planning, FORMAS
Box 1206
111 82 STOCKHOLM
Sweden
Tel: +46/8/775.40.00
Fax: +46/8/775.40.10
Email: uno.svedin@formas.se

Dr Halldór Thorgeirsson
Ministry for the Environment
Vonarstraeti 4
150 REYKJAVIK
Iceland
Tel: +354/560.96.00
Fax: +354/562.45.66
Email: halldor.thorgeirsson@umh.stjr.is

Dr. Ph. Arnolds Ubelis
Institute of Atomic Physics and Spectroscopy
University of Latvia
Raina bulv. 19, Riga, LV-1586
Republic of Latvia
Tel: +371/7/22.97.27
Fax: +371/7/82.01.13
Email: arnolds@latnet.lv

Mr Pierre Valette
CEC - DG Research, SDME D1 (7/80)
Unit 1: Policy matters
Square de Meeûs 8
1050 BRUSSELS
Belgium
Tel: +32/2/295.63.56
Fax: +32/2/295.20.97
Email: Pierre.Valette@cec.eu.int

Mr Dirk Van Evercooren
Advisor Study Council Flemish ABVV
Hoogstraat 42
1000 BRUSSELS
Belgium
Tel: +32/2/506.82.24
Fax: +32/2/512.36.86
Email: dvanevercooren@vlaams.abvv.be

Prof. Jean-Pascal van Ypersele
Institut d'astronomie et de géophysique G. Lemaître
(ASTR)
Université catholique de Louvain (UCL)
Bâtiment M. de Hemptinne
Chemin du Cyclotron 2
1348 Louvain-la-Neuve
Belgium
Tel: +32/10/47.32.96
Fax: +32/10/47.47.22
Email: vanypersele@astr.ucl.ac.be

Mrs Sara Verbeiren
VITO
Integrale Milieustudies
Boeretang 200
2400 MOL
Belgium
Tel: +32/14/33.59.53
Fax: +32/14/32.11.85
Email: sara.verbeiren@vito.be

Mrs Hilde Van Dongen
Federal office for scientific, technical and cultural affairs
Wetenschapsstraat 8
1000 BRUSSELS
Belgium
Tel: +32/2/238.34.92
Fax: +32/2/230.59.12
Email: vdgn@belspo.be

Mr Marc Van Heuckelom
Federal office for scientific, technical and cultural affairs
Wetenschapsstraat 8
1000 BRUSSELS
Belgium
Tel: +32/2/238.35.55
Fax: +32/2/230.59.12
Email: vheu@belspo.be

Mrs Martine Vanderstraeten
Federal office for scientific, technical and cultural affairs
Wetenschapsstraat 8
1000 BRUSSELS
Belgium
Tel: +32/2/238.36.10
Fax: +32/2/230.59.12
Email: vdst@belspo.be

Prof. Aviel Verbruggen
Universitaire faculteiten St. Ignatius Antwerpen
Departement Studiecentrum Technologie Energie en Milieu
Kleine Kauwenberg 12
2000 ANTWERPEN
Tel: +32/3/220.49.00
Fax: +32/3/220.49.01
Email: aviel.verbruggen@vlaanderen.be

Dr Stefan Vetter
Federal Ministry of Agriculture, Forestry, Environment and Water Management
Department II/1
Stubenring 1
1010 WIEN
Austria
Tel: +43/1/711.00.67.10
Fax: +43/1/711.00.21.42
Email: stefan.vetter@bmlf.gv.at

Dr Karl Ulrich Voss
Federal Ministry of Education and Research
Section 423: Cleaner Production and Sustainable Products
53170 BONN
Germany
Tel: +49/1888/57.28.37
Fax: +49/1888/578.28.37
Email: karl-ulrich.voss@bmbf.bund.de

Dr Matthias Weber
Austrian Research Centers
Department Technology Policy
2444 SEIBERSDORF
Austria
Tel: +43/50/550.38.65
Fax: +43/50/550.38.88
Email: matthias.weber@arcs.ac.at

Dr Christopher West
Natural Environment Research Council
Polaris House, North Star Avenue
SN2 1EU SWINDON
United Kingdom
Tel: +44/1793/41.17.40
Fax: +44/1793/41.16.91
Email: c.west@nerc.ac.uk

Mr Jacques Wisenberg
Conseiller
Cabinet du Commissaire à la Politique scientifique
Square de Meeûs 23
1000 BRUSSELS
Belgium
Tel: +32/2/506.57.46
Fax: +32/2/511.86.56
Email: -

Mr Hansvolker Ziegler
BMBF
Environmental Research and Social Sciences
Heinemannstrasse 2
53175 BONN
Germany
Tel: +49/228/57.34.50
Fax: +49/228/57.36.10
Email: Hansvolker.Ziegler@bmbf.bund.de