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Monitoring Policy and Research Activities on Science in Society in Europe (MASIS)

Final synthesis report

Research and Innovation

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Directorate-General for Research and Innovation
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Monitoring Policy and Research Activities on Science in Society in Europe (MASIS)

Final synthesis report

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Abbreviations and Acronyms

QA	Quality Assurance
ALB	Albania
AT	Austria
BE	Belgium
BG	Bulgaria
CH	Switzerland
CSO	Civil Society Organisation
CY	Cyprus
CZ	Czech Republic
DE	Germany
DK	Denmark
EE	Estonia
EL	Greece
ES	Spain
FI	Finland
FYROM	Macedonia
FR	France
GDP	Gross Domestic Product
GM	Genetically Modified
GMO	Genetically Modified Organism
HR	Croatia

HU	Hungary
IE	Ireland
IS	Iceland
ISR	Israel
ICT	Information and Communications Technology
IT	Italy
LIE	Liechtenstein
LT	Lithuania
LU	Luxembourg
LV	Latvia
MASIS	Monitoring Policy and Research Activities on Science in Society in Europe
ME	Montenegro
NGO	Non-Governmental Organisation
NL	Netherlands
NO	Norway
PISA	Program for International Student Assessment
PL	Poland
PT	Portugal
RO	Romania
SE	Sweden

SI	Slovenia
SIS	Science in Society
SK	Slovakia
SRB	Serbia
TR	Turkey
UK	United Kingdom

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1 Executive summary

One of the guiding principles of the FP7 Science in Society programme which is part of the 'Capacities' Specific Programme under the Seventh Framework Programme is to contribute to the implementation of the European Research Area through the development of structural links and interactions between scientists, policy-makers and society at large. The aim of the European Commission has been to address this challenge and stimulate further cooperation in Europe via the identification of common resources, common trends, common interests and common challenges. The service contract entitled 'Monitoring Policy and Research Activities on Science in Society in Europe' (MASIS) under the Capacities Work Programme Science in Society (2008) has been instrumental to this end.

The main activities of the MASIS project were the design, collection, validation and update of 38 national reports on science in society, and the creation, maintenance and update of the MASIS website (www.masis.eu) as well as the facilitation of a MASIS community and collection of information (news) pertinent to MASIS from the 38 countries.

MASIS has been implemented over a two-year period by COWI A/S (contractor) and the Danish Centre for Studies in Research and Research Policy at Aarhus University. In addition, ContentCube were responsible for the website development and maintenance and Rumfang for website design.

The executive summary presents the horizontal findings across the 38 national reports followed by procedural lessons concerning project execution.

Science in society across EU 27 and 11 associated countries

The national reports provide a background for analyses of trends and patterns related to science in society in Europe. The report at hand provides a series of horizontal comparisons of activities and policies across 38 European countries (one country report remains incomplete and is not included in the analyses) within a range of thematic areas, including national debates and policies relating to the place of science in society, priority setting, public participation, and governance concerning science in society, research priorities and structures, and science communication activities. The national MASIS reports demonstrate that several common features can be identified across Europe, but there are also significant differences and clustering of countries in some areas. The main findings are the following:

› **Science in society in Europe is dominated by certain issues**: Issues related to the role of science and technology for sustainable development and issues related to the governance of science are dominant among the national debates emphasized in the reports.

› **Increased responsiveness by higher education to societal demands:** Significant reforms of higher education institutions, combining increased autonomy and professionalization of management, have swept across Europe and have stimulated a higher degree of responsiveness towards societal demands, particularly in the shape of increased science – industry interaction.

› **Heterogeneous models and levels of public engagement in science and technology decision making in Europe:** While many countries have formalized procedures and opportunities for involving citizens in priority-setting and assessment related to science and technology, the actual degree of public involvement differs significantly, and in some countries, nascent civil societies, lack of appropriate institutions, or non-inclusive political culture, form barriers for a more democratic and inclusive governance of science and technology. The issue of ‘upstream engagement’, which has some resonance at the EC level, seems to have only moderate saliency in many member states.

- **Significant differences in the use of scientific knowledge and advice in decision making:** Many countries experience a growing concern with developing infrastructures for feeding scientific knowledge and advice into political decision making processes. In some countries, formal procedures and institutionalization do not, however, instrumentally ensure a high *de facto* use of science-based knowledge in decision making, whereas other countries have both well-established traditions and institutions and an extensive use of science in decision making, particularly within policy areas such as health and environment.

- **The MASIS reports highlight the leading national institutions:** The MASIS reports provide a rich database of actors involved in defining the relationship between science and society within specific areas including ethics in science and technology, equality, diversity, and inclusiveness in scientific institutions, science communication, and technology assessment. The mapping of these actors depict variation across the four main areas, however, judging from the examples stated in the national reports, some actors, including governments and ministries along with universities and other higher education institutions, seem to have a leading position in setting agendas and shaping the relationship between science and society.

- **The EC Framework Programme provides key value added in understanding the role of science in society:** With regard to research activities and priorities relating to science in society, the national reports point at significant efforts in several areas, including governance of science, public understanding of science, science communication, science education, and ethics in science and technology. Science in society is generally not considered a coherent and well-defined research field, and several correspondents note that continued research efforts related to science in society is dependent upon the EC Framework Programme support structure. Advances in the understanding of the appropriate place of science in society thus depend on a collective European commitment to supporting further research within this area.

- **Science and technology communication is gaining attention**: As a trend across all countries, public communication of science and technology is gaining attention within governments and other institutions, particularly with regard to stimulating science communication at schools and aimed at younger people in general. The number of actors involved in science communication is increasing, adding to the complexity of the field, but also involving new formats and modes of communication, particularly through web-based media but also large-scale interactive initiatives such as science festivals. Science Weeks (or –Days, -Nights, or -Months), Science Fairs, Science Centers, Festivals and major exhibitions are mentioned by almost all correspondents as good and successful initiatives, often instigated by government bodies, networks or foundations. Most good practices identified in Europe thus involve face-to-face interaction or hands-on exploration of science, but there are also several examples of successful communication in traditional media such as TV programs, radio shows or public lectures/presentations.

- **Science journalism is slowly developing:** An area of concern in many European countries is the lack of qualified science journalists. Some countries have established science journalist education programs, but more often training of science journalist takes the form of voluntary courses or sporadic workshops. Also the professional support system for science journalists, i.e. science journalist associations, is underdeveloped in most countries. There is, however, a nascent trend towards increasing training activities for scientists and students in science communication practices.

- **Three categories of ‘science communication culture’:** Based on six parameters of science communication activity, a framework for assessing and categorising ‘science communication culture’ was developed. Three distinct clusters of countries were identified, namely countries with a ‘consolidated’, ‘developing’, and ‘fragile’ science communication culture. Within each of these categories, countries display similar characteristics and report on similar challenges. Science communication culture tends to interconnect also with issues related to governance of science and public involvement in science and technology decision making.

› **Case study of the nuclear accident in Japan (2011) shows substantial policy reactions across Europe:** The nuclear accident at Fukushima Daiichi has caused substantial amounts of media coverage and public debate across Europe concerning the future role of nuclear energy sources. Issues related to the impacts of controversial technologies, prominently risk implications, governance of science, trust in scientists and expertise, and public involvement in science and technology decision making have been key in these debates. The Fukushima catastrophe has also prompted substantial policy reactions across Europe. While some countries have consolidated their energy strategies in the wake of the accident, other countries, such as Austria, Germany, and Switzerland, have implemented or decided on policies radically affecting the status of nuclear technology as a future energy source.

› **The MASIS project has established a unique database of knowledge on science in society in Europe:** The main result of the MASIS project is the establishment of an extensive, validated, and easily accessible database with information on issues pertaining to science in society across Europe. Each of the 37 national reports available at www.masis.eu offers an extensive insight into national activities and policies related to science in society, and, in combination, the reports provide an invaluable reservoir of information which, we contend, will allow for further research and analyses of the role of science in society in Europe.

Recommendations on science in society

1 The adequacy or appropriateness of science in society cannot be satisfactorily assessed on the basis of singular perspectives or criteria. The dimensions relevant to discussions about the appropriate place of science in society stretch from global to local concerns and include not only issues related to risk or ethics, but a range of other environmental, social, economic, and cultural components. *It would be useful if future activities and studies within the field of science in society could explore* ***integrated*** *approaches to science and technology assessment, where multiple components are taken into account, including assessment of the anticipated and wider environmental, economic, ethical, social, and cultural impacts of scientific and technological developments.*

2 Discussions and processes relating to assessing the appropriateness of science in society should be inclusive and based on broad public and stakeholder engagement. The national MASIS reports clearly show that the degree of success in 'opening up' such process vary significantly across Europe, and that formalization or institutionalization of public engagement does not guarantee a high de facto degree of public participation. As the 2012 SiS Work Programme rightly notes, 'the Europe 2020 societal challenges can only be tackled effectively if society is fully engaged in science, technology and innovation', and *it should be stressed that the dynamics of public and stakeholder engagement remains an important object for further research and experimentation.*

3 Europe has witnessed extensive policy developments relating to the place of science in society, particularly concerning the interaction of science and industry, and significant attention has been devoted to creating structural conditions at research institutions that stimulate societal responsiveness and innovative capacity. As the 'Innovation Union' Flagship Initiative clearly underlines, research and innovation are key drivers of competitiveness, jobs, sustainable growth, not least in a context of financial crisis and increased global competition, and it is useful to note the pivotal importance of understanding the processes that lead to sound decisions about research, innovation and scientific institutions, i.e. understanding the governance models of science and technology. *In both public debate and SiS research at the national level, governance issues play a dominant role, and it is advisable to support continued efforts within this area.*

4 As a research field, Science in Society is characterized by complexity and heterogeneity, and the national systems for supporting research activities within this field differ significantly. Several correspondents note that continued research efforts related to science in society is dependent upon the EC Framework Programme support structure. *Advances in the understanding of the appropriate place of science in society thus depend on a collective European commitment to supporting further research within this area, also within the new structure of the Horizon 2020 framework.*

5 The main result of the MASIS project is the establishment of an extensive, validated, and easily accessible database with information

on issues pertaining to science in society across Europe. Each of the 37 national reports available at www.masis.eu offers an extensive insight into national activities and policies related to science in society, and, in combination, the reports provide an invaluable reservoir of information which, we contend, will allow for further research and analyses of the role of science in society in Europe. *It is recommendable that focused research activities, in which the MASIS reports are used as empirical information, are encouraged, and that the MASIS material is made available to the SiS scientific communities as well as national and European stakeholders and decision makers.*

2 Introduction

This report provides an overview of results emerging from the European-wide project on 'Monitoring Policy and Research Activities on Science in Society in Europe' (MASIS). 38 participating countries, covering the EU and countries associated with the Seventh Framework Programme, have provided extensive information on national research efforts, policies, and communication activities relating to science in society, different models and use of scientific advice and expertise for policy making, and activities related to assessment and ethical issues of science and technology. An appointed correspondent for each country has developed a national report monitoring trends, policies, actors, and activities relating to science in society, based on a common reporting template. The final synthesis report at hand provides information on cross-cutting issues and trends in Europe relating to science in society, based on analyses of the national reports.

2.1 MASIS objectives

The overall objective of the MASIS project is to contribute to the guiding principle of the science in society programme of developing structural links and interaction between scientists, policy-makers, and society at large. The project is instrumental in stimulating further cooperation in Europe and reducing fragmentation through the identification of common resources, common trends, common interests, and common challenges related to the interaction of science and society in Europe. MASIS was initiated in January 2010 and the project duration has been two years.

The main tasks of the MASIS project include:

- The establishment, coordination and quality control of a network of national high level experts and practitioners (correspondents) to provide a description, analysis and annotated commentary on the national landscapes of science in society.

- Regular data collection and reporting over a 21 months period (month 3 to 24) in 38 countries - following a common template targeting main issues related to science in society.

- Analysis and reporting of results, including the production and updating of national reports every six months (by the network of national correspondents), bi-annual analyses of emerging issues, and the final synthesis report at hand.

- The development and launch of a user friendly, interactive website for mapping and updating of high quality, comprehensive and up to date information on various science in society policies, activities, and research priorities.

The monitoring activities in this project can be regarded an extensive 'follow-up' to the report 'Challenging futures of science in society: emerging trends and cutting-edge issues'[1], which was drafted by an expert group and published by the European Commission in 2009, as the first output of the European Commission's MASIS initiative. The report identifies and discusses European trends related to the role of science in society, but the authors stressed a need to provide robust empirical data by systematically gathering information on national policies and activities, in order to arrive at a more fine-grained picture of science in society in Europe. The current activities (2010 - 2011) in the MASIS project have aimed to provide such information.

2.2 Methodology

The MASIS project involves 38 countries; 27 EU member states and 11 countries associated to FP7. In each of the 38 participating countries, a

[1] Siune, K. et al. (2009): *Challenging Futures of Science in Society: Emerging trends and cutting-edge issues*; European Commission.

national correspondent has been appointed by the contractor, COWI. Data collection in the MASIS project is based on the network of national correspondents, who have been recruited on the basis of their experiences and knowledge of research, policies and practices related to science in society in their respective countries. Each correspondent has provided a comprehensive report and subsequent updates based on a common guideline and template.

The first version of the guideline and template was developed based on advice from the network of national correspondents, as well as discussions with authors of the report on 'Challenging futures of science in society: emerging trends and cutting-edge issues', which forms part of the background for the monitoring activities in the project. In addition, DG Research and a network of national validators appointed by the Commission offered comments and advice. A revised, final version of guidelines and template was developed based on experiences from writing and analyzing the preliminary reports, and on the basis of collective deliberations at a joint workshop for correspondents in September 2010.

While the template covers core elements of science in society, it does not exhaust the range of issues that could potentially be included. Given the complexity of the field and the methodology applied, it has not been the intention to achieve an exhaustive mapping, but rather to identify important examples of policies and activities, including examples of good practice. It should be noted also that the MASIS monitoring activities follow the initial MASIS report in using the term 'science' in its broadest sense, as in the German 'Wissenschaft', covering also the social, economic and human sciences.

The questions contained in the guideline are answered on the basis of the correspondents' expertise and assessment. Most correspondents have, however, made use of their national networks and consulted other key persons in their country, conducted interviews or workshops, in combination with exploring other data sources, in order to enhance the quality of the information provided in the national reports. There has been no set methodology for data collection, as the appropriate means for data collection differ significantly between countries and also depend on the position and expertise of the individual correspondent. In order to enhance transparency with regard to methodology, an appendix has been included in the report template, in which correspondents have made notes regarding the methods that they have used to collect information, whom they have consulted and how, which documentary sources have been used, suggestions of particularly favourable ways of retrieving data, and specific complications or difficulties in finding relevant information. The appendix on methods and sources is for internal project and validation purposes, and it has not been included in the published version of the reports.

Each report has been validated in a rigorous QA process, which includes both formal / technical validation internally by the project management, collective validation as part of the joint workshop, and substantive validation of each national report, by an external validator appointed by the European Commission.

2.3 Data collection

By December 2011, 37 national reports had been submitted, validated, and uploaded to the MASIS website. The empirical material contained in these reports forms the basis for the results presented in the final report. The national report from Malta has not been satisfactorily completed and has consequentially not been accepted by the national validators. Thus, the Maltese report has been omitted from the analyses presented in this final synthesis report.

One of the important features of the MASIS project has been the continuous collection of new information and updating of the national reports. Throughout 2011, until the end of the contracted project period, national correspondents have had the possibility to revise and update their individual reports, when important activities or policies have emerged in the national context. The most recent version of the national report is available on the MASIS website, www.masis.eu. In addition, a new section containing new information has been added since the interim report presented to the Commission in June 2011. Specifically, the new section places its focus on the role of science and technology in relation to climate change, energy consumption, and resource depletion, with particular emphasis on nuclear energy and European responses to the nuclear accident at the Fukushima Daiichi power plant in Japan. Within a very short time span, Europe has seen substantial policy responses to the catastrophe, and it has been discussed whether the regulatory reactions actually reflect scientific advice, and whether policy responses are proportionate to the real risks of accidents at European nuclear power plants. The complex interaction of public concerns, media coverage, stakeholder involvement, and policy making, is a relevant case for exploring the role of 'Science in Society', and the dynamics of responsible research and innovation. This topic is included as the last chapter of this final synthesis report.

2.4 Contents of national reports and data accessibility

The common reporting template is arranged around four main themes:

- 'National context', which describes current and recent debates about the relationship between science and society in the respective countries, national trajectories with regard to the place of science in society, and recent policy developments concerning science in society.

- 'Priority setting, governance, and the use of science in policy making', focusing on the different actors involved in shaping the relationship between science and society, formal and informal procedures for public engagement with science, and national processes and procedures for using science-based knowledge and scientific advice in policy-making processes.

- 'Science in Society related research activities', with the purpose of describing the scale and scope of research efforts in the respective countries, including emerging themes, targeted areas, strategies for embedding science in society issues in mainstream research, and funding structures and opportunities for science in society research.

- 'Activities related to science in society', which aims at monitoring the variety of different activities particularly concerned with public communication of science and technology, the intensity and complexity of science communication in the respective countries, and the actors involved.

- 'The Fukushima accident', as mentioned above, provides a case exploration of the role of science and technology in relation to climate change, energy consumption, and resource depletion, with particular emphasis on nuclear energy and European responses to the nuclear accident at the Fukushima Daiichi power plant in Japan.

Each national report can be read ‘vertically’ as an extensive description of policy- and research activities related to science in society in a specific country. This implies that users of the reports, who are particularly interested in science in society in e.g. the Netherlands or Albania, can read the Dutch or Albanian report. But given the common, detailed structure of the reports, they can also be read ‘horizontally’, i.e. selectively focusing on a single or several issues – corresponding to sections or subsections in the reporting template, and for analytical and comparative purposes, this is equally interesting.

The MASIS website, www.masis.eu, provides the full, vertical reports in pdf-format. The site also includes facilities for combined horizontal and vertical selection of data. This means that users can extract specific topical information, e.g. related to the issue of ‘upstream public engagement’ or ‘current debates about the place of science in society’, for a self-selected group of countries. For the purposes of achieving maximal analytical flexibility, the 37 validated reports have also been coded to a NVivo database in a two-step procedure, involving first technical and secondly substantial coding of national reports. The results presented in the report at hand are based on analyses of the material by way of horizontal comparisons, based on extractions from the NVivo database.

3 MASIS results

The transformations of science and its interactions with society is a subject of increasing academic and political attention. In the context of globalisation and transition towards knowledge based economies, governments as well as international institutions emphasise the importance of scientific and technological developments for enhancing national competitiveness, and the demand for strategic, relevant knowledge production is further infused by global challenges related to climate change and resource depletion, and the need for science-based, sustainable solutions in this regard. The interplay between science and society plays a central role in these developments.

Science and its place in society is being transformed by external pressures and expectations interacting with developments from within. New areas of research activity transcend disciplinary boundaries, and fracture the demarcation of science and technology. Info-, bio-, nano-, and cogno-innovations take place in collaborative constellations where universities, industry and policy makers interact, and these areas prompt not only an overreaching re-contextualisation of science in society, but also a significant change in the very notion of the academic profession and the culture of conducting research.

Throughout Europe, extensive political reforms have altered research and higher education at the institutional level, and the academic debate concerning these reforms has been intensifying. Sweeping changes have been layered upon each other within a short span of time, affecting research management systems, funding systems, quality control systems and incentive structures at higher education institutions, often based on generic governance models adopted from other policy areas. Transparency, accountability, efficiency, and productivity have become important targets in science policy.

The semantic turn from 'Science and Society' to 'Science in Society' as part of the progression from the sixth to the seventh EU Framework Programme emphasises a growing awareness that scientific knowledge production is a social activity within this changing context. It also recognizes the complexity and subtleness of the relation between science and society and the embeddedness of science in a broader cultural and political context. 'Science in society' is a broad notion, covering e.g. political and public debates and initiatives related to the place of science in society, changes in academic institutions and the role and responsibilities of the individual scientist, communication of science in multiple formats and among various societal actors, and procedures for public involvement in decision making related to science and technology.

The following sections of this report will present results emerging from the MASIS national reports concerning the five main thematic areas: (1) National context, (2) Priority setting, governance and use of science in policy making, (3) Science in Society research activities, (4) Science communication activities and (5) The Fukushima accident. The aim is to highlight cross-cutting issues and trends, in order to provide an empirically based picture of science in society in Europe.

It is important to note, that the main result of the MASIS project is the establishment of an extensive, validated, and easily accessible database of information on issues pertaining to science in society across Europe. Each national report supplies an extensive insight into national activities and policies, and in combination, the reports provide an invaluable reservoir of information which will allow for further research and sophisticated analyses of the role of science in society in Europe. The descriptive analyses presented below merely scratch the surface of the potential applications of the database, and it is our hope that future research projects will capitalize on the opportunities for in-depth analyses.

3.1 National context

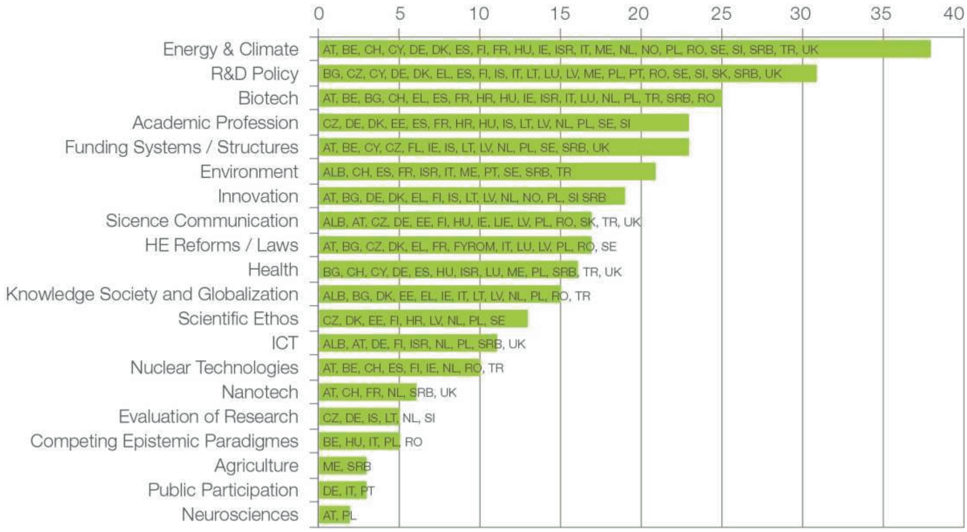
The first main section of the national MASIS reports is concerned with the national context for science in society. The reports describe current and recent debates about the relationship between science and society in the respective countries, national trajectories with regard to the place of science in society, and recent policy developments concerning science in society.

Current debates on the role of science in society

The national reports have identified important current and recent national debates related to the overall place of science in society. For each debate, correspondents were asked to provide a keyword and description of the substantive issues at stake, a specification of the arenas in which the debate has taken place, and an assessment of the role of citizens in the debate. In processing the data, the identified debates have been classified into 20 categories presented in figure 1 below, in which they are ordered by magnitude of appearance. ISO country codes are incorporated in the bar chart with the purpose of specifying in which countries these debates have been important[2]. A limited number of specific debates have been coded to two or more of the 20 categories. Below, the contents of the dominant debates are further described.

[2] A list of abbreviations can be found on the last page of the report.

Figure 1 *Main debates on the place of 'science in society'; overall no. of reported debates*



Energy and climate change

The most dominant public debates relating to the role of science in society across Europe have revolved around energy and climate change. The national MASIS reports clearly demonstrate the intensity of public and academic discussions surrounding energy policies and climate change. Across Europe, the role and potential of science and technology within a context of resource depletion and global warming has been a major issue, not least on the backdrop of the COP 15 climate summit which took place in December 2009, i.e. shortly before the MASIS data collection commenced. The demand for scientific advice and evidence in energy- and climate policy making along with demand for alternative, sustainable technologies for climate change mitigation, have been important issues in most countries. The climate change challenge has also - to varying degrees – affected public engagement with science and invoked new formats for public participation in decision making, and it has raised questions related to governance of science, trust in scientists and expertise, and funding of research and development. The high visibility of natural scientists, e.g. climatologists and meteorologists, has been an element connecting science with society, and the discussions relating to sustainable developments and renewable energy have involved stakeholders in both academic, political, and broader public arenas. The challenges that were brought forward into the discussions on this topic encompass issues such as: public confusion and distrust in the accuracy of climate science (Romania), the handling of radioactive waste related to the implementation of nuclear plants as a low carbon power option (United Kingdom, Ireland)[3], consequences of biodiversity loss related to the implementation of hydro plants on rivers and creeks (Turkey), and local societies being affected by the development of national wind and solar farms (Cyprus, Italy).

R&D policy

Related to other categories, such as *Globalization and the knowledge economy, reforms of higher education institutions, innovation, research funding* and *the academic profession*, are debates on the national R&D strategies and policies. Most of these debates underline the importance of R&D development for national competitiveness, meeting societal, economic and industrial objectives. These debates are most often played out in the academic arena, with a moderate degree of intensity in the public and political fields. Moreover it is noticeable, that more than half of these debates take place in the eastern European countries. This could be connected with the fact that these countries as new EU member states are striving to make their R&D activities comparable with other European systems and join the EU effort to coordinate national science and technology policies.

Biotechnologies

Specific debates related to *biotechnologies* are widespread across Europe. Both medical and agricultural biotechnologies have been discussed and the debates cover a variety of topical concerns such as; bioethics, health, safety, environment, and biotech as a prioritized future research field. In particular, debates over GMOs, reproductive technologies and stem cell research have been observed in many countries. The challenges brought into discussion on this topic include the following sensitive issues: religious resistance toward different sorts of biotechnological intervention in nature and human life (e.g. infertility treatment (Poland), prenatal testing and genetic screening (Israel), embryonic stem cell research (Italy, Spain)), administering new experimental drugs without informed consent (Israel), the role of GM food and crops in a longstanding culinary tradition

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[3] It should be noted, as shown in the last chapter of the report, that the Fukushima disaster has invoked a U-turn in nuclear policies in several countries.

(Italy), public resistance towards the liberalization of the cultivation of GMO in nature (Bulgaria) and the uncertainties and risks related to medicine (Switzerland). Most of the debates on this topic are ongoing and have been played out in both political and public arenas with citizens taking an active role in some countries. This result is in concurrence with the latest Eurobarometer survey on the European public and sensitive technologies, which suggests that Europeans want to be involved in the governance of particularly controversial technologies within the life sciences[4].

Academic profession

The debates concerning issues related to the *academic profession* is intertwined with several of the other categories relating to institutional developments in higher education, and national policies on research and development. As a result of the development towards knowledge based economies across Europe, the recruitment and maintenance of scientific researchers have become crucial. The problem of creating attractive research careers appears to be a significant part of this challenge, and has led to some debate in the Netherlands, Spain and Hungary. Another hot topic is the relationship between science, business and politics in the knowledge based economy. The role of researchers in business and policy making is one out of several discussions on this topic. One example concerns the kinds of science-based knowledge and scientific advice that are put to use in policy-making processes (Estonia), another refers to the problem of political pressure on evidence-based decision making (Finland), and a third relates to the possible conflicts of interest in the relationship between research and industry (Sweden). These examples have bearing on the status of the academic profession, and involve questions about academic freedom of individual researchers and the institutional autonomy of higher education institutions (Croatia, Denmark, Estonia, Finland, Latvia). Another important discussion in this context concerns the intensified control, evaluation and assessment of scientific research and the ranking of national universities and research results in an international perspective, which also provides a new context for the

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[4] Gaskell, G. et al. (2010): *Europeans and Biotechnology in 2010: Winds of change? A report to the European Commission's Directorate-General for Research; European Commission.*

academic profession and academic identity (Czech Republic, Iceland, Lithuania, Netherlands, Slovenia). In addition, the German report outlines discussions on the continuous challenge of increasing the share of female full professors in the science system. These debates are played out in the public, political and academic area with academics taking an active role in a few countries.

Funding systems / structures

An important element in the significant changes in the infrastructures of the national higher education and research institutions is *research funding*. In total twenty three debates were described on this topic. Five of these concern the relationship between basic and applied research (Czech Republic, Iceland, Latvia, Sweden, UK). The increasing national emphasis on scientific innovation and the focus on commercialization of knowledge have had a crucial impact on the prioritization and distributional mechanisms for research funds, not least in terms of developments towards performance-based research funding. The debates on this issue are most often played out in the academic and political fields, with little direct involvement of the public. Other hot topics regarding the funding of research and higher education concern issues such as the economic prioritization of specific scientific fields; the evaluation, assessment and management of quality and efficiency in research; the establishment of competitive research funds; the implementation of 'excellence' policy allocating money to the best universities and the best performing research groups, and the reduction of research funding as a part of general budgetary adjustments in the context of economic crisis.

Environment

Specific discussions related to the environment are similarly widespread across the European public. Most of them are played out in the public arena, with citizens taking an active role in several countries. The topics and the level of details concerning the description of the environmental issues vary a lot, as the following enumeration indicates; Albania (industry and traffic related air pollution in the cities, biodiversity protection initiatives, environmental hotspots, the problem of toxic waste and issues related to the import of green list waste); Israel (regulating air quality/instituting 'polluter pays', cell phones and the placement of antennas, legislation concerning recycling, industrial waste and biodiversity etc.); Montenegro (ecology & tourist related environmental issues); Portugal (environmental risks); France (issues related to biodiversity); Switzerland (sustainable water management, research projects regarding the Swiss glaciers); Turkey (biodiversity problems in relation to the establishment of hydro plants); Serbia (environmental protection), Spain (restrictive laws on the environment e.g. limiting the speed around big cities); Italy (disputes over waste disposal technologies)[5].

Innovation

As a result of the developments towards knowledge based economies across Europe, the innovation agenda is becoming a highly prioritized topic. The increasing relevance of this field appears to be a response to changing global economic developments. Most of the debates on this topic emerge from the European emphasis on the role of science for economic growth/recovery and enhancement of national competitive advantages, as indicated below in the section on globalization and the knowledge based society. As the German correspondent notes, science is regarded the main driver to enable and provide knowledge and technology for innovation. While the innovation agenda in some countries is particularly fuelled by the challenges of the international economic crisis (e.g. Iceland, Finland, Greece), other countries note a more general strategy to strengthen innovation systems as a means for enhancing competitiveness on an international level (Austria, Bulgaria, Denmark, Germany, Netherlands, Norway, Latvia, Lithuania). The question on how to combine science and research policies with industrial and market policies, and stimulate innovation systems through economic investments and political initiatives seems to be the core challenge in most of the countries emphasizing the innovation agenda, and the current debates regarding this topic involves discussions on themes such as the implementation of transfer activities of R&D organizations, the commercialization of academic research through extensive management and funding reforms, the establishment of a culture of entrepreneurship at higher education institutions, prioritizing user and demand oriented

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[5] As it appears, the varying level of details in the national descriptions of environmental issues plays a decisive role with regard to the overall numeration of debates. Therefore 21 topics is probably not an accurate number, however, the significance of environmental debates involving questions related to the role of science in society is evident.

research, establishing intermediary institutions for support of knowledge transfer, and creating technology incubators at universities.

Science communication / Science education

Several of the debates related to the issue of scientific communication concern the perceived declining interest in science and technology among students and emphasize the crucial importance of promoting mathematics, natural sciences and technology in the national school systems. Austria, Germany, UK, Hungary, Ireland, Estonia, and Turkey are all countries, in which concern with the future challenge of recruiting researchers within these specific fields have been a topic for debate. The structural challenge have fostered national discussions on questions such as how to change the reputation of 'hard sciences' among youngsters (e.g. through media), how to make science education in school more engaging, how to increase the interest in natural sciences among female students and how to recognize researchers who undertake public engagement activities. The OECD programme for international student assessment (PISA) might be seen as an important stimulus for these debates.

However, the debates on this topic do not only concern the promotion of science to children and young people, but also the public as a whole. For example, the UK, Estonia and Slovakia emphasize national discussions on societal challenges such as how to build public confidence and engagement in science through SIS activities (UK), how to create a more positive attitude towards natural sciences in the public (Estonia), and how to develop a national strategy for the popularization of science (Slovakia). Another interesting issue concerns the use of ICT in science communication. While debates about benefits and risks of Open Science have been debated in Finland and Poland, the importance of a national Internet age programme and E-schooling has been debated widely in Albania. The debates concerning science communication have been played out in both the public, political and academic arenas.

Reforms of higher education institutions

During the last fifteen years several European countries have experienced significant changes in the infrastructures of academia including extensive reforms of *higher education institutions*. The debates over these reforms place particular emphasis on the different discussions at a national level about connecting scientific institutions with societal needs, processes of university mergers or fusions, new university laws and concentration of efforts at higher education institutions within strategic areas. The European development towards knowledge based competitive economies appears to be of major influence on the design of these reforms, which can be characterized in terms of the following features: privatization, commercialization, internationalization, concentration, streamlining, external management and competitiveness. The debates on these structural changes, often in conjunction with policy decisions and implementation, have tended to be moderately important in public domains, but significantly more vibrant in political and academic arenas with students and researchers taking an active role in certain countries (e.g. Austria, Italy and Latvia). Transformation of universities and other sites for knowledge production has thus been a pertinent issue over the last years.

Health

The role of science related to health issues is widely debated all over Europe. One of the most visible debates on this topic was the national handling of the worldwide outbreak of the H1N1-flu epidemic. This epidemic led to several national discussions (Belgium, Cyprus, Germany, Israel, Switzerland, Turkey) on which precautions and preventive initiatives should be taken to reduce the consequences and spreading of the virus. Additionally there were significant debates related to questions on the availability of vaccination and the efficiency of certain measures related to prevention and containment. The following debates regarding public health were also considered important with regard to the place of science in society: the public health safeguards, health care challenges related to demographic change, mobile phone radiation, public health hazards related to industrial waste, the over-prescription of antibiotics, food safety, epidemic animal diseases, government regulation in regard to the vaccination of children, government regulation on state-supported medicine and pharmaceuticals, new laws on public health (e.g. public smoking restrictions), the cost of social health insurance, the efficiency of the health care system, and implications connected to online medical research and healthcare. The above mentioned debates mostly took place in the public and political arena. The academic arena was to a lesser extent a site for these debates.

Globalization and the knowledge based society

The effects of globalization and the development of knowledge based economies are similarly widely debated topics across Europe. Six debates regarding these issues emphasize the role of science and education for economic growth and the identification and enhancement of national competitive advantages on international markets (Bulgaria, Germany, Netherlands, Greece, Latvia, Lithuania). Creating stronger ties between academia and industry, and generally stimulating innovation systems, is a recurring element in these discussions, and the European Union's Lisbon Strategy of making Europe the most competitive dynamic knowledge-based economy by 2010, and the connected Barcelona declaration which sets the aim for Europe to increase R&D investment to three per cent of European GDP, clearly provide a context for debate in several countries.

As a result of globalization and the above mentioned developments, some countries have been experiencing structural challenges, particularly the so called *brain drain phenomenon*, which has threatened the scientific developments in Italy, Lithuania, Poland and Turkey and led to several national discussions. Other debates concern issues such as the use of national and international language in academia (Estonia), and the theme of public and private space in the capitalized economy (Albania). The debates have been played out in academic, political and public arenas, and most of them are considered endemic, or continuous, issues of public concern.

Scientific ethos

Issues related to the question of scientific ethos have also been the subject of several debates across Europe. Some of these debates take their starting point in the structural reforms that have characterized the development of higher education institutions and public research areas in several countries, and concern issues such as the academic freedom of the individual scientist as well as institutional autonomy of universities (Croatia, Denmark, Estonia, Finland, Latvia), the commercialization of science and its impact on academic values (Poland), the relationship and balance between quality and quantity in science and the priority of 'excellent' as compared to 'average' science (Czech Republic).

In addition, there have been several debates concerning the legitimacy of science and research in society. For instance, themes such as corruption, scientific misconduct, unethical behavior and conflicts of interests have been the subject of four national debates (Sweden, Estonia, Croatia, Poland). Another debate topic is the development of new codes of conduct in modern sciences (Netherlands). This debate is related to national discussions over ethical, legal and societal issues emerging from modern science and technology. Most of the debates mentioned above are epidemic, relating to a particular incident or case, and have been played out in public and academic arenas.

Nuclear technologies

The discussions on the topic of nuclear technologies are framed by competing views on benefits and risks related to nuclear energy (Austria, Belgium, Finland, Ireland, Netherlands, Romania, Spain, Switzerland, Turkey). On the one hand there is concern about aspects such as safety and security risks and the environmental problem of waste management. On the other hand discussions emphasize benefits like the possibility to reduce carbon emissions and avoid the national dependence on imported fossils. Additionally, the national membership of CERN (The European Organization for Nuclear Research) has also been a topic of discussion in Austria and Turkey. The debates regarding nuclear technologies have taken place in all arenas, with citizens taking an active role in some countries. Since the submission of the first MASIS reports, the nuclear accident at the Fukushima Daiichi power plant in Japan has captured policy agendas across Europe and media debate and public reactions have been notable. European reactions to the catastrophe will be a particular topic of the last chapter of this report.

ICT

Finally, information and communication technologies (ICT) have been a topic of debate in several European countries. The discussions concern controversial issues such as data privacy and data security risks of modern ICT and the challenges brought forward into discussion on this topic encompass; privacy issues related to social networks (Germany) privacy risks related to biometric databases and National Health Service records (Israel, UK) and cyber crime (Germany). In addition, there have been identified discussions on ICT related issues such as mobile phone radiation (Germany, Israel), ICT as a high priority national R&D strategy (Poland, Serbia), e-based education in public schools (Albania) and online medical research and medicine (UK). The debates have been played out in public, political and academic arenas.

Main clusters of debates

As the review of topical concerns above indicates, the debates relating to the interactions of science and society are comprehensive throughout the EU and the countries associated with the Framework Programme. The national reports clearly indicate that science cannot be understood as an autonomous subsystem located at the boundary of societal awareness. Scientific and technological developments play a crucial role for economic competitiveness and social conditions, health, environment, and sustainability, and science penetrates all spheres of society. While the emerging picture of debates related to science in society certainly is multifaceted, some patterns and observations in the material do stand out. In figure 2 below, the 20 categories have been further collapsed into six overreaching problem areas that provide different framings of science in society. The following points could be highlighted:

› It is evident that discussions about the rightful or appropriate place of science in society concern multiple levels, ranging from the global context to specific, or local, issues. Going from left to right in figure 2 below, we find that debates on science in society stretch from considerations about science's problem solving capacity towards the global issue of resource depletion and demand for sustainable alternatives to fossil energy sources. Equally 'global' is the major role that science plays in the global knowledge economy, and the significance of scientific institutions in the national strategies for navigating on global markets. Further towards the right, a major cluster of debates deals not with the global or national perspective, but revolves around issues at the institutional level, particularly related to the sweeping reforms of universities in many European countries. Further on, we find discussions at the individual or professional level concerning e.g. working conditions, the character of academic work, and identity of academics. Finally, specific topical issues and particular controversial technologies equally raise debate about the role and place of science in society. Overall, the analyses of debates identified by the correspondents thus point towards the multi-level and complex interactions of science and society.

› Clearly the issue of climate change and the debates about the role of science and technology for sustainable development are commonly emphasized in the reports. But it is noteworthy that issues related to the *governance* of science, e.g. institutional reforms and transformations, national strategies in science and technology policy, and policies supporting innovation and science-industry interaction, are very widespread across Europe, even if these debates often tend to be played out in academic and political circles, and to a lesser degree in the public arena. Overall, the European debates on the appropriate role of science in society thus clearly involve considerations about the purposes and motivations for science and technology and their anticipated and wider impacts in terms of both risks and benefits, and call for collective reflexion and deliberations among stakeholders from academic, political, and public arenas. In turn, these discussions are linked with considerations about appropriate regulation and governance of science and technology. Such concerns are important dimensions of the emerging notion of 'responsible research and innovation', which is currently gaining attention at the European level.

Figure 2 Debates; collapsed and ordered categories

Policy goals and priorities

Similarly to the procedure for identifying important public debates, national correspondents were asked to identify major policy initiatives, reforms, and developments of decisive relevance to the overall place of science in society. This section will concentrate on outlining the main initiatives which reflect key trends across Europe in terms of policy areas, objectives, and impact related to national policies.

In outlining important policy initiatives and reforms, a multifaceted and complex picture emerge, depicting different concerns, developments, and types of initiatives taken in the European countries. Nevertheless, several common themes, goals and priorities emanate. The main trends delineated by several correspondents are presented below.

Technology, innovation and R&D investments

In outlining the main policy initiatives of major relevance to the overall place of science in society, one main trend comes prominently across: European countries are to a high degree concerned with enhancing innovation, research and development stimulating and advancing knowledge based economies, economic growth, international competitiveness and, in turn, quality of life (health, education, welfare etc). Thus, various strategies, policies, reforms and laws have been adopted to enhance science, technology and innovation, research and development. In some countries, particularly in the new member states and associated countries, the development of national R&D strategies is in its early stages, but across Europe, the European Union's Lisbon Strategy of making Europe the most competitive dynamic knowledge-based economy by 2010, and the Barcelona declaration which sets the aim for Europe to increase R&D investment to three per cent of European GDP, clearly provides an impetus not only for extensive debate, but also for a range of political initiatives and reforms.

Reforms of higher education institutions and funding systems

Economic stimulation of R&D and innovation is accompanied by reforms of higher education institutions, which have taken place throughout Europe. Several countries have witnessed new university laws and also other public sector research institutions have been reorganized. The purposes of enhancing university autonomy while at the same time professionalizing university management have provided a framework, within which specific reforms have been implemented. In several countries, models for university funding have been changed, often based on intentions to increase the use of performance-based criteria for distribution of funding, in order to increase the competitiveness and output awareness of universities. Several correspondents express that these objectives have had significant impact on university strategies and have led to changes in university cultures all over Europe. Research funding systems more generally have to a large degree been reorganized in several European countries and new funding structures have been implemented, for instance by establishing new councils and agencies or by reforming existing funding organizations. The objectives of these reforms have, in several countries, been to implement new and improved competition structures, distinguish more clearly between curiosity-driven, researcher-initiated research on the one hand, and strategic, demand-driven research on the other hand. Formalized science – industry interaction has emerged as a threshold criterion for research funding in some of these new structures. Furthermore, some of the associated countries, such as Albania and Montenegro, stress the importance of obtaining an 'associated status' which allows them to participate fully in the EU's Framework Programmes and in this way build up scientific expertise and international collaboration.

Science – industry interplay

The European countries are to a high degree concerned with promoting cooperation between science and industry. Through the implementation of various action plans, policy initiatives and strategies, new and increased interactions between universities and the business sectors are stimulated in order to increase the efficiency of innovation systems, technology-transfers, R&D investments and in general fostering competitive and dynamic knowledge based economies. For instance, several countries have implemented programmes and funding schemes aimed at strengthening the science-industry interplay and the commercialization of science. Albeit the science-industry interplay is prioritized and recognized to be pivotal, the actual impact of policies in terms of increasing interaction differs among the European countries.

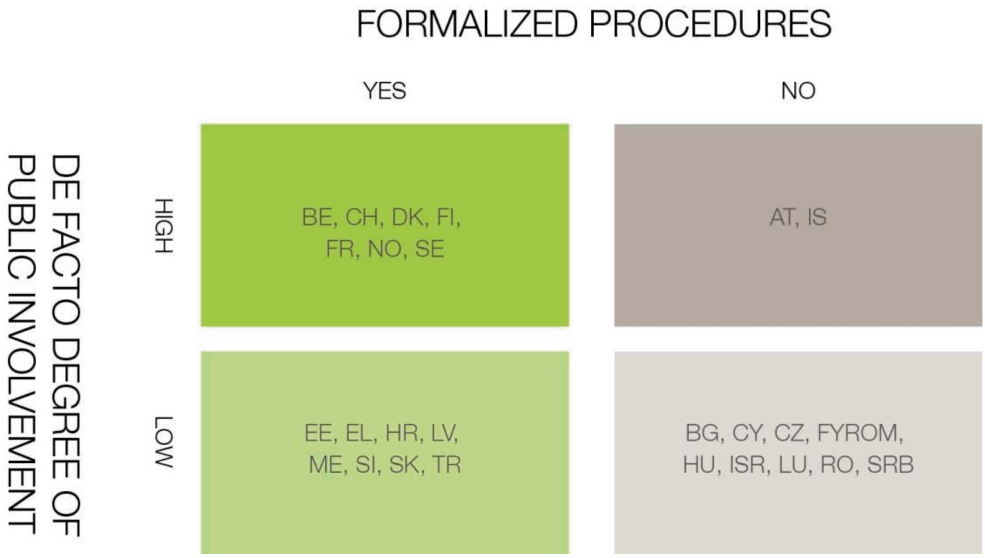
3.2 Priority setting, governance and use of science in policy making

The national reports cover issues related to priority setting, governance, and the use of science in policy making, focusing on the different actors involved in shaping the relationship between science and society, formal and informal procedures for public engagement with science, and national processes and procedures for using science-based knowledge and scientific advice in policy-making processes. On the issue of public involvement a mixed picture emerges.

Public involvement in science and technology decision making

The national reports identify formal procedures for citizen involvement and they also assess the actual degree of citizen involvement in science and technology decision making. These two dimensions, each contributing to the overall democratization of science and technology decision making, are not always related in a straight-forward way. The majority of the national correspondents identify some formalized procedures for involving citizens in priority setting and assessment related to science and technology, but in some of these countries, the actual degree of public involvement is in fact considered to be low. Opportunity does not always imply action, and, in addition, different opportunity structures are not equally effective in creating a fertile context for citizen participation. On the basis of these two dimensions, countries might be grouped into four main categories as figure 3 below illustrates. The typology does not capture all countries, and indeed in some countries, the information contained in the reports does not allow for an appropriate analysis up against the proposed typology.

Figure 3 Models of public involvement in science and technology decision making



Formalized procedures and high de facto degree of public involvement

Countries within this category are characterized by having formalized procedures for citizen involvement combined with extensive actual citizen participation in priority setting in regard to science and technology issues. The Nordic countries, for instance, have strong traditions and formalized procedures for involving citizens in decision making processes and assessment activities related to science and technology. This reflects a more general 'corporatist' political culture of decision making, where stakeholders, such as employer associations and trade unions, are systematically included in policy making across different policy areas, in line with both NGOs and advisory boards and committees. The renowned 'Danish model' for technology assessment based on public participation and deliberation, e.g. in the form of consensus conferences, remains important in Europe, even though the model has come under pressure within the Scandinavian countries, and at present is under severe attack in Denmark, where the Danish Board of Technology, who invented the consensus conference format, is being abolished. Furthermore, countries such as France, Belgium, and Switzerland also have traditions for involving the public in decision making related to science and technology.

Formalized procedures but low de facto degree of public involvement

Some countries have formalized procedures for citizen involvement in science and technology decision making, for instance in terms of specific laws and the possibility for public hearings, but the de facto degree of democratization of science and technology decision making in terms of public involvement is low. This seems to be especially the case for some eastern European countries such as Montenegro, Slovenia, Slovakia and Croatia. Still, also within these countries, initiatives to promote citizen involvement are emerging, for instance in the shape of public consultations and debates.

No formalized procedures but some degree of public involvement

Some countries, such as Iceland and Austria, do not have specific formalized procedures for involving the broader public in science and technology decision making per se; yet they might have well established general practices for involving the broader public directly in the processes of decision making. In Austria, for example, there are no formal procedures for citizen involvement targeting science and technology, and public debates about these issues are in fact limited, yet citizens can use formal standard procedures of representative and direct democracy, as in the case of the 'Volksbegehren', to influence the processes of priority setting also in relation to science and new technologies.

No formalized procedures and low degree of public involvement

Several correspondents, e.g. from Cyprus, the Czech Republic, Hungary, Serbia, Macedonia and Bulgaria, report of no formalized procedures for citizen involvement specifically in science and technology decision making, nor strong traditions or practices for public participation in general. In these countries, the issues of inclusive governance and public engagement in science have low saliency.

Overall, however, there is a general trend across countries to involve the public in decision making processes particularly related to environmental topics. For instance, a resolution for 'Public involvement in the environmental decision making process' has been passed in Albania, securing the ability of the general public to participate in priority setting and assessment activities. In Belgium, procedures for involving citizens are considered to be the most stringent when it comes to policy areas on environmental issues and in Finland, formalized consultation processes regarding assessment activities are established through the Law on Environmental Impact Assessment. Public consultations have here been organized, e.g., in order to assess the environmental impact of nuclear waste disposal sites.

Citizen- or CSO-initiated activities with political impact

In addition to assessing the ‘top-down’ provided opportunity structure for public participation in science and technology, correspondents were also asked to identify ‘bottom-up’, citizen or civil society organizations-initiated activities with notable impact on decision making related to science and technology. Based on the national reports, there is only modest implementation of citizen- or CSO-initiated activities with substantial influence on policy making related to science and technology in Europe as a whole[6]. Public debates and NGO- and ‘grass-root’ initiated activities do take place, however the national reports only emphasize a few concrete examples, in which bottom-up activities have had a direct influence on political decision making[7]. These examples tend to revolve around specific topics and controversial technologies and concern activities such as involvement in the development of a national strategy for energy development (Montenegro), local resistance to the implementation of co-incineration (Portugal), local resistance to the building of a dam which would flood a famous open air site for Palaeothilitic art in Europe (Portugal), local resistance to infrastructural changes (Germany), resistance to national GMO related activities (Lithuania, Slovenia, Switzerland, Turkey, UK), resistance to the establishment of environmentally questionable hydro plants (Turkey), resistance to the building of nuclear power stations and the storage of nuclear waste (UK, Germany), a citizen-based initiative to allow stem cell research for the treatment of human diseases put into action by patients´

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[6] With a long-standing tradition of citizens and CSOs bringing issues related to science and technology in to the political agenda, Germany deviates somewhat from the rest of the countries on this topic.

[7] It should be mentioned that it arguably is complicated to assess the direct and indirect political impact of bottom-up activities.

associations (Spain), and charity-based fundraising to investigate specific kinds of diseases (Spain).

On the whole, it seems that public participation is primarily channelled through the formal procedures for citizen involvement as described above and thereby through more organized and, sometimes, consensus-oriented forms of involvement. For instance, there have been identified several examples of citizens and CSOs operating through participation in advisory boards, committees and consultative bodies. These kinds of public participation concern topics such as drafting legislation affecting business (Albania), prioritization and funding of research (Belgium, Croatia, Netherlands, Romania), policies in S&T (Turkey), ethics in science (Norway, Iceland), the interface of technology and society (Norway), building and planning (Israel), and nuclear power (UK).

Importance of upstream engagement

The national correspondents were asked to describe whether the debate about 'upstream' as opposed to 'downstream' engagement could be seen as relevant in their country, and whether there were any initiatives promoting upstream engagement. The general trend is that this question has not received particular attention in national contexts, and that initiatives promoting upstream engagement are scarce[8]. However, some correspondents underline the importance of the topic in academic circles and among practitioners of science communication (Czech Republic, Denmark, Ireland, Romania), while others point to upstream engagement as an early stage 'work in progress' (Italy, Hungary, Portugal)[9].

Several correspondents do describe examples of good practice and attempts to involve citizens in priority setting and debate at early stages of decision making (Albania, Austria, Cyprus, Czech Republic, France,

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[8] It should be recognized that, although upstream engagement might not be a particularly debated topic, examples of such engagement may nonetheless occur. Some correspondents (Lithuania and Norway) find it complicated to separate the national discussions on 'upstream' and 'downstream' public engagement as independent debates.

[9]Germany also deviates on this topic with citizens, CSOs, political parties, and churches promoting upstream engagement.

Israel, Netherlands, Portugal, Turkey, UK), particularly in relation to controversial topics such as stem cell research, environmental issues, nanotechnology, health, and GMOs. These activities are most often initiated by governmental institutions, but there have also been identified some examples of university-initiated activities (Belgium, Liechtenstein), and an FP7 funded project (Israel). Furthermore, citizens have also been involved in 'foresight activities' in terms of giving their input to the prioritization of future strategic research areas within the field of science and technology (Denmark, Germany, Hungary, Luxembourg, Romania, Spain, Sweden).

Use of science in policy making

Finding the appropriate place and role of science in society is not merely a matter of societal involvement in setting priorities and defining the agenda for research, it also concerns the reciprocal relationship, i.e. the extent to which science-based knowledge and advice is adequately used in policy making processes. The MASIS correspondents have been asked about the national procedures for using science-based knowledge and scientific advice in policy making processes and about trends at the national level in this area.

Formal procedures and advisory bodies involved

Procedures for using science-based knowledge and scientific advice in policy making are rarely based in legislation, but rather institutionalized or performed through different kinds of practices and by means of a variety of advisory bodies. Scientific evidence is applied across different policy areas, however, some areas, including health and environment, are more frequently mentioned as particularly dependent on science-based knowledge. Similarly to the section on public involvement, it is possible to distinguish two dimensions relating to the use of science-based knowledge in decision making. One dimension concerns the extent to which a formalised structure for feeding science-based knowledge into decision making is in place, e.g. in terms of institutional sites dealing with these processes. The other dimension concerns the extent to which science-based knowledge and advice have a real impact on decisions. Based on these elements, four categories of countries can be identified. A graphical presentation of the distribution of countries within these categories is presented in Figure 4.

Highly formalized procedures and high saliency

Countries within this category, among others the Nordic countries and Germany, have strong traditions for using science-based knowledge in political decision making processes. Procedures for applying science and evidence-based knowledge in policy making are formalized in several ways and implemented through a range of different advisory bodies: governmental directorates, sectoral research institutes or agencies, committees and working groups, in which scientific experts interact with civil servants and stakeholders, and provide relevant scientific knowledge for policy processes. These different advisory bodies often exert significant influence on the decision making processes.

Less formalized, but with considerable influence

Some correspondents report that their countries do not have a particularly extensive institutional structure or strong formalized traditions for science-based policy making. But at the same time, science-based knowledge does play an important role in decision making processes with a considerable degree of *de facto* influence on policy processes. Countries belonging to this category are, among others, Austria, Belgium, and Switzerland. A range of advisory boards, often provisional but sometimes permanent, are in place in these countries, for instance in the shape of commissions, science boards, and councils, but to a lesser degree than in the first group of countries.

Formalized procedures but low impact of science-based knowledge in policy making

In Romania and Albania, particular formalized procedures are in place. For instance, in Albania, a law on environmental protection states that advisory councils should be composed of individuals representing research institutions and NGOs, among others. Though, even with such formalized instruments aimed at applying scientific advice in policy making, the *de facto* impact of the scientific evidence emerging from these bodies on decision making processes appears to be modest.

Low degree of science-based knowledge in policy making

A number of countries report that no formalized procedures for science-based policy making are established. This is the case for countries such as Serbia, Slovakia, Slovenia, and Turkey. This is not tantamount to not applying procedures and advisory bodies at all, given that all countries mentioned here do apply science-based knowledge to a limited degree and, for instance, have implemented various councils. The procedures for applying science-based knowledge in policy making, however, does not seem to have a high degree of impact on political decisions within this cluster of countries.

Figure 4 The use of science in policy making; grouping of countries

Trends at national level

With regard to national trends related to the application of research and scientific advice in policy-making processes, half of the national correspondents report, more or less explicitly, of an increase in the use of scientific advice in recent years, whereas the other half of the correspondents describe a more or less stable situation. In some eastern European countries, increasing use of science-based advice in policy making is ascribed to influences from Europe in general, including affirmative effect from their EU memberships. Several countries report of establishment of new advisory bodies. For instance, new expert committees on technological innovations have been created in Austria, along with a National Bioethics Committee in Cyprus, while a number of 'think tanks' have been founded in Finland. Contrary to the general trend, the Norwegian correspondent explicitly reports of a decrease in use and impact of scientific advice on policy making. As outlined above, Norway has had a strong tradition for using science-based knowledge in political decision making processes, but nevertheless, discussions on the appropriate use of experts and a political questioning of the legitimacy of experts have led to a decrease in influence on policy processes. Similar discussions concerning the character of expertise and the independence and disinterestedness of scientific advice is emerging in the Netherlands. Figure 5, below, shows the distribution of the countries within this topic area.

Figure 5 *Trends regarding the use of science in policy making at national level*

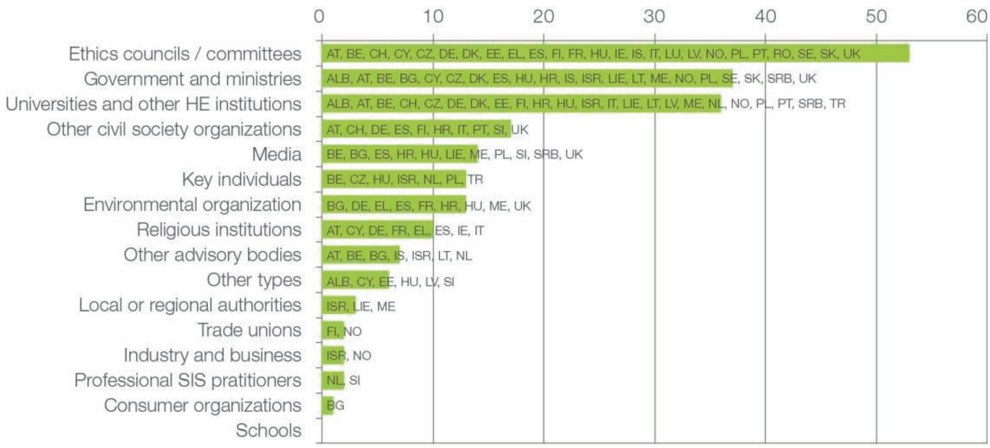
Key actors in science and technology governance

Various key actors and stakeholders are involved in setting and influencing the agenda related to important SIS issues and activities. At the intersection between science and society, these actors are important in shaping the link between science and society, and in negotiating and assessing the practices and trajectories of research and innovation. In order to map the national landscape of actors involved in connecting science with society, the national correspondents were asked to identify five or more key actors within four main areas: 1) *Ethics in science and technology,* 2) *Equality, diversity, and inclusiveness in scientific institutions,* 3) *Science communication,* and 4) *Technology assessment*. The mapping of these actors depict great variation in scale and scope of actors within and across the four main areas; however, judging from the examples stated in the report, clusters do appear and some actors, as for instance governments and ministries along with universities and other higher education institutions, seem to take a leading position in setting the agenda in the four main areas, whereas, for instance, professional SIS practitioners take a less influential position.

Actors concerned with ethics in science and technology

In terms of ethical issues in science and technology, the main actors appear to be ethics councils / committees. These councils are engaged with various matters, but ethical issues related to research institutions, biotechnology, bioethics and medical ethics are dominating concerns. Other key actors involved with ethics in science and technology include governments / ministries and universities and other higher education institutions. Other civil society organizations dealing with topics such as stem cell research and reproduction are noted as stakeholders as well. Furthermore, compared to the other main areas, religious institutions appear to play a certain role across Europe in ethical matters related to science and technology. For instance, the Catholic Church is especially concerned with issues of stem cell research and other bioethical questions, and the church is in several cases referred to as having an influence on policy processes within these areas. Ethics in science and technology come across as important concerns in most European countries, and all countries, except for Macedonia, state that they have several actors in place dealing with ethics in science and technology. In addition, some correspondents note that discussions related to 'scientific integrity' have materialized recently.

Figure 6 *Actors concerned with* ethics in science and technology*; no. of references and distribution of countries*

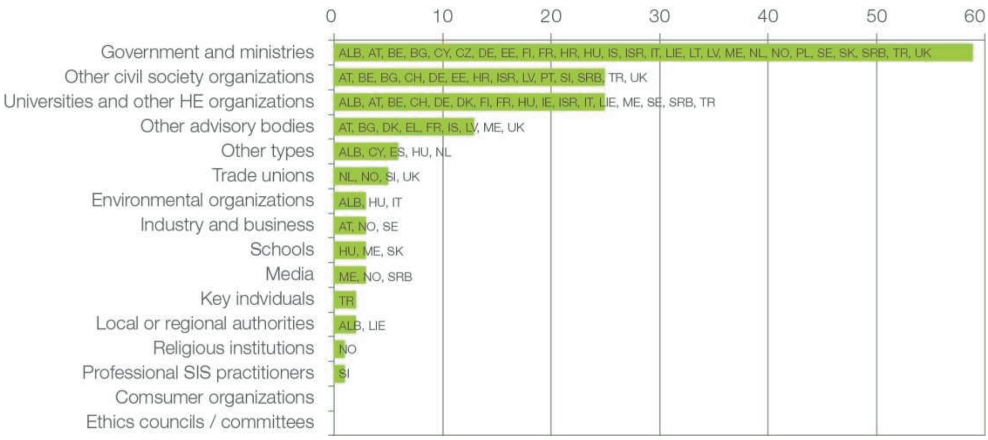


Actors concerned with equality, diversity, and inclusiveness in scientific institutions

Issues related to equality, diversity, and inclusiveness in scientific institutions are primarily dealt with at two main levels: the governmental level including ministries related to education, science, technology and research, and the other level is the third sector in which different civil society organizations are engaged with issues related to equality in scientific institutions and aim, for instance, at including less privileged groups in various scientific institutions. Student associations are represented within this category as well. Universities and other higher education institutions are also involved by implementation of various equality programmes. The most salient discussions within this area are stated by the correspondents to be 'social mobility of immigrant children' and 'inclusion in the educational system and scientific institutions' together with concerns of 'preventing brain drain'.

Luxembourg, Macedonia, and Romania state that they do not have any specific actors operating within this area. Furthermore, the area of equality, diversity and inclusiveness does not appear, if one disregards questions of gender inequality[10], to be a subject of major institutional mobilisation in any of the remaining countries.

Figure 7 Actors concerned with equality, diversity, and inclusiveness in scientific institutions; no. of references and distribution of countries



Actors concerned with science communication

When it comes to the enhancement of science communication, on the political level, as well as influencing science communication practices, the dominant stakeholders are identified as governments and ministries along with universities and higher education institutions. With regards to the latter, universities are involved in setting the agenda for science

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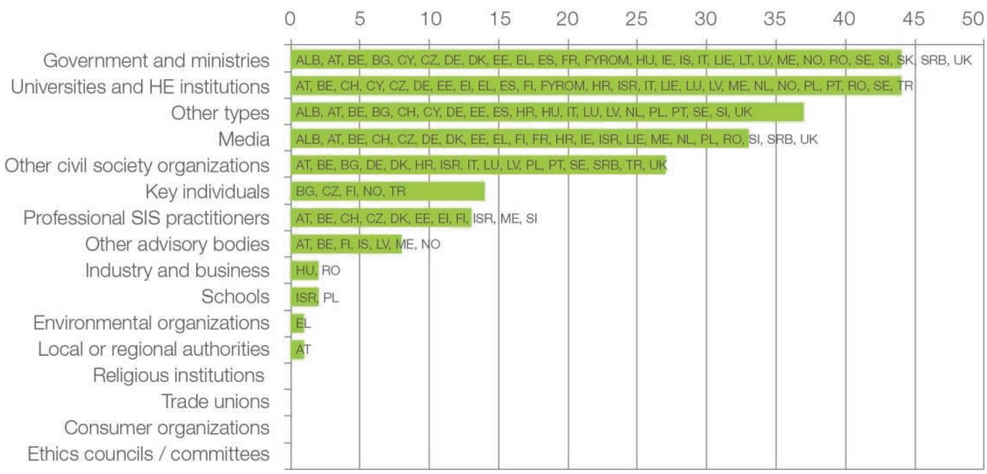
[10] It should be mentioned here that the issues of 'women in science' is specifically not included in the MASIS project in accordance with the terms of reference for the project. There exist important frameworks and fora for coordination and benchmarking of policy activities across the EU. The outcome of the meta-analysis on Gender and Science Research (RTD-PP-L4-2007-1) covers these issues (initiated in April 2008): http://www.genderandscience.org/web/index.php

communication by promoting particular kinds of dissemination formats, including development of science centres and outreach programmes, among others. As shown in figure 8 below, ‘other types’ of actors, falling beside the pre-coded categories, are also key within the area of science communication. These stakeholders include different science academies, museums, science centres, research institutes and research funding organizations / councils. In 22 countries, the media also plays a central part, not only in disseminating science-based knowledge, but also in stimulating national developments in the area. The media is here broadly represented by various formats such as newspapers, journals, TV and radio.

Figure 8 *Actors concerned with* Science communication*; no. of references and distribution of countries*

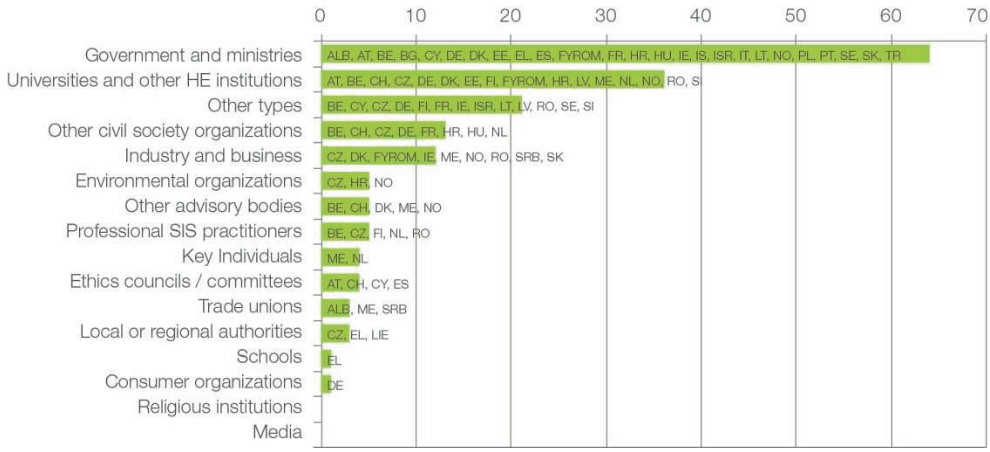


Actors concerned with technology assessment

Technology assessment activities, in the template defined as ‘formalized, systematic analyses of possible consequences related to particular technologies’, do not, compared to the other three main areas, appear to be an equally comprehensive and systematic practice in Europe. Two national correspondents (Luxembourg, UK) state that they could not identify any actors involved in technology assessment while several other national correspondents report that no strong traditions for technology assessment are present in their respective countries. Countries which do perform technology assessment in a more systematic and extensive manner include primarily the ‘old’ EU15 member states, such as the

Netherlands, Austria, Belgium and other countries represented in the European parliamentary technology assessment network. Actors involved in technology assessment are primarily governments and ministries together with universities and other higher education institutions. The category 'other types' is ranked as a key actor by the national correspondents. This category includes dedicated institutions for technology assessment, research institutes, research funding organizations and different state agencies involved in technology assessment.

Figure 9 *Actors concerned with* technology assessment*; no. of references and distribution of countries*



3.3 Science in Society research activities

A section of the reporting guideline and template deals with research activities related to science in society, aiming at monitoring the scale and scope of research efforts in the respective countries, including emerging themes, targeted areas, strategies for embedding science in society issues in mainstream research, and funding structures and opportunities for science in society research[11].

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[11]It should be noted that MASIS is concerned with mapping research activities which are not fully EU funded. The correspondents report on national as well as

Priorities in 'Science in Society' research

The national correspondents were asked to state five or more examples of research projects or larger research programmes, ongoing or completed within the last five years, which relate directly to science in society issues. Furthermore, the correspondents were asked to specify, if their examples could be categorized within one or more of the following six predefined thematic areas: 1) Public understanding of science, 2) Governance of science, 3) Science education, 4) Science communication, 5) Equality and social inclusion in science, and 6) Ethics in S&T. If none of these predefined categories matched the research project in question, correspondents specified the field of study themselves. In some cases, projects have been categorized as relating to two or more thematic areas[12].

The main proportion of thematic references fell under the pre-defined categories, and the remaining projects with individually specified thematic classification, were subsequently coded to seven main categories emerging from the data: 1) Social sciences and humanities, 2) History and sociology of science, 3) Climate and environment, 4) Scientific institutions and practices, 5) Health, 6) Biotech and its impact on society, and 7) ICT and information society. Figure 10 below shows the distribution of references to these and the predefined thematic areas.

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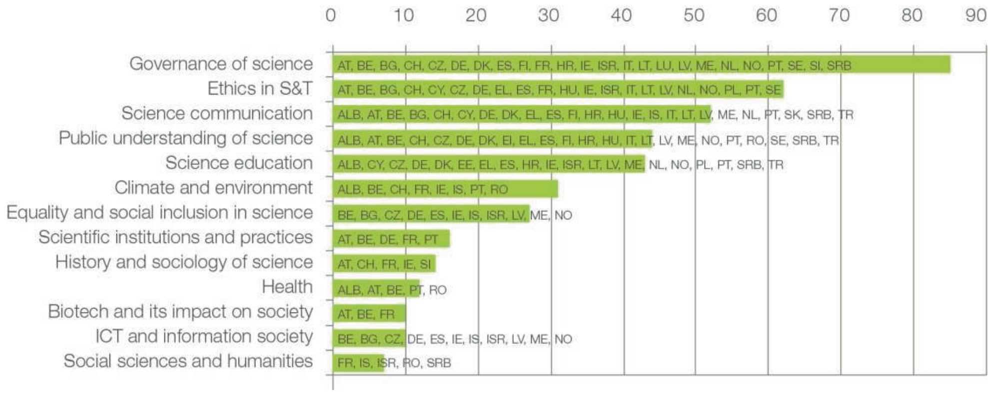
international research efforts, but not activities funded solely under the framework programs. This is consistent with the terms of reference for MASIS.

[12] In addition to thematic area, correspondents have provided the title, web-link if possible, name of participating institutions, and budget, for each research project included. This information can be retrieved at the MASIS website.

Figure 10 Science in Society research priorities, no. of references[13]



Most projects relate to the areas of ‘governance of science’, ‘ethics in science’, ‘science communication’, and ‘public understanding of science’, but several projects also refer to the areas of ‘science education’, ‘climate and environment’ and ‘equality and social inclusion in science’. Some common trends and patterns can be identified:

Governance of science

Governance of science is a dominant general research theme in SiS research, listed here by 24 countries[14]. Among the projects mentioned by the national correspondents are several related to issues such as R&D policies, governance of new and controversial technologies, transformations of higher education institutions, commercialization of science, funding and quality assessment of research, scientific social responsibility, research management, and public participation in science

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[13] In relation to this graphical presentation it is important to underline, that the range of research activities that might be included under the umbrella of science and society in United Kingdom has made it impractical to search potential funders’ websites for details of individual projects. However the UK correspondent lists a number of national councils and academic centers doing research in SIS-areas such as science education, science communication, ethics in science and technology, public engagement in science, biotechnologies and governance of science.

[14] As mentioned above, the correspondents were asked to state examples of research projects or larger research programmes which relate directly to science in society issues. However, on the basis of this material it is not possible to outline any information about the specific focus or subject of interest of the reported projects/programmes.

related policy. Several correspondents also classify research projects on innovation processes, policies and –systems, e.g. projects aimed at exploring interactions among science and industry and projects aimed at gaining knowledge for decision making processes, as reflecting issues of governance.

Ethics in science and technology

Ethics in science and technology is also a dominant issue among the various research priorities. Especially three trends related to ethics can be identified among the listed research projects: 1) projects relating to biotechnology and bioethics are widespread, 2) human genetic databases and related issues, e.g. management of data collection, bio banks, and health registers, also figure prominently, and 3) a more general perspective focusing on the role of ethics in science, including ethically based regulation in academic science, values, and the responsibility of science in contemporary societies.

Science communication

Science communication is another common research theme which covers a wide array of topics related to communication. In 24 countries, one or several important research projects on science communication are listed, and the projects are concerned with general dissemination and communication of scientific knowledge and technologies and of the specific risks related to these. The project descriptions focus on themes such as e-schooling, controversial technologies, ICT and cultural participation, technological development, traditional and electronic publishing, innovative science communication approaches, promotion of mathematics and natural science education, audio visual science, social inequality and environment, development of measures for science popularization, health communication and structural changes in mass media, among others.

Public understanding of science

Public understanding of science is another thematic research area which is vigorous in both new and old member states and in associated countries. In total, 23 country reports describe research projects related to public understanding of science, and several correspondents focus particularly on how it is possible to raise awareness of, and interest in, science among the general public, and these projects are often connected with areas of science communication and science education. Citizen engagement and understanding of various scientific topics and technological developments, e.g. synthetic biology, stem cell research, nanotechnology, climate change, innovation processes and health are also prominent across several countries. The development towards knowledge based societies across Europe is clearly reflected in widespread research efforts within thematic areas such as *public understanding of science* and *science communication*.

In the category of research projects relating to *science education* two particular observations can be made. First, science education is a common research topic in the new member states for countries such as Cyprus and Estonia as well as in the associated countries, for instance Albania and Serbia. Research conducted here tends to focus on the promotion of science education at the national level, with a focus on both teacher competences and student learning processes. Secondly, science education is also a research topic within some Northern European countries; Ireland, Denmark, and Norway. Included in projects carried out in these countries are issues relating to relevance of science education, developments in engineering education, and advanced methods in science teacher education.

Climate and environment

Climate and environment are stated as topics for science in society research in eight countries[15]. These projects concern different issues such as biodiversity protection, sustainability (agriculture, resources), pollution (air, noise, waste), domestic use of energy, risk management, environmental awareness, and climate variability and predictability.

Equality and social inclusion in science

Equality and social inclusion in science is a topic visited 27 times in the material. Ten countries list research projects targeting issues such as equal opportunities at universities, recruitment in scientific environments, the digital divide of the information society, poverty and technology, international data on social inequity and environment, among others[16].

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[15] The high rate of project references relating to climate and environment is partly explained by the fact that Belgium and Albania listed these topics 5 and 15 times, respectively.

[16] It should be mentioned here that the issues of ‘women in science’ is specifically not included in the MASIS project in accordance with the terms of reference for the project. However examples of research projects concerning gender equality are listed in some national reports. Germany, for instance, lists more than twenty projects concerning this topic.

In addition to the research projects conducted within the scope of the above mentioned areas, several countries have emphasized other non-pre-coded research priorities: *Scientific institutions and practices* embrace a broad array of topics including projects focusing on social networks, transnational cooperation among 'National Contact Points', future development of science and technology, the relationship between educational research and practice, converging scientific fields, and other areas; *History and sociology of science* is a rather general cluster covering various projects that the correspondents have chosen to connect with disciplines rather than thematic areas; *Health* covers project themes such as environment and health, biotech and health, road traffic and health, vaccination, functional food, electromagnetic fields, perceptions of health science, and health communication; *Biotech and its impact on society* concerns research areas such as genome research, societal and political implications of DNA analysis, the impact of biomedical practices on family, prenatal diagnoses and handicap prevention, among others; *ICT and the information society* include, for instance, projects on the digital divide, youth and gaming, ICT and cultural participation, web 2.0 and E-democracy; *Social sciences and humanities* embrace various projects related to political science, law, anthropology, economy and so forth, and indicates that research in the area of science in society sometimes relate directly to traditional academic disciplines.

Trends and cross-cutting issues in Science in Society research

In addition to highlighting specific research projects within an overreaching 'Science in Society' umbrella, the national correspondents were asked to delineate emerging themes and cross-cutting issues in current science in society research in their respective countries. In terms of emerging thematic priorities in science in society research, the areas identified above are clearly considered important. In addition to the monitoring of thematic research priorities related to science in society, two main points of attention also emerge in relation to cross-cutting issues and trends:

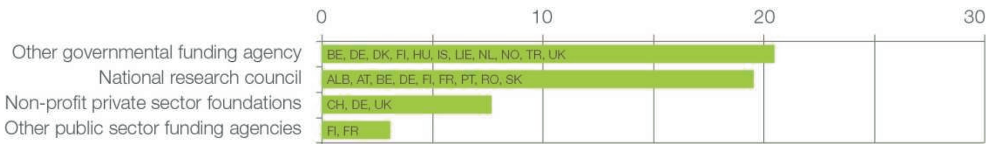
› Science in society is not a coherent or consistent research field with clear boundaries and well-developed research infrastructure in most countries. On the contrary, many correspondents note the complexity and interdisciplinary character of Science in Society, and the lack of clear demarcations and dedicated research sites. In total, 19 country reports explicitly emphasize a lack of strong and well-defined Science in Society research efforts. In several cases, weak institutionalization, limited national funding schemes, and absence of SIS scientific reviews, are mentioned as part of the explanation. Some countries, such as Norway and the Netherlands, do indeed have academic institutions or research centers that are targeted directly at science in society issues, but in many countries, not least in the new member states, the research activities related to science in society appear to be rather sporadic and, for instance, based on Ph.D.-level projects and individual research activities. Systematic and concentrated national research efforts on science in society are scarce.

› As a direct consequence of the lack of strategic national efforts on science in society research in many countries, the importance of the Framework Programme support structure for research in this area is strongly emphasized in the national reports. Several correspondents (Hungary, Cyprus, Sweden) note that the framework programme is the sole vehicle for accelerating efforts, because there are no funding available on a national level within this area, while others underline insufficient national funding sources (Czech Republic) and an undeveloped SIS research culture (Ireland) as the explanation for this tendency. It is clearly essential for further development and progression of research on science in society that European support mechanisms are in place.

Funding for research on Science in Society

In 19 out of 37 countries, funding programmes for SIS research do exist to some extent. As outlined in figure 11 below, funding for SIS research is primarily distributed through two main funding agencies: national research councils and other governmental funding agencies (including ministries). Figure 11 counts the research funding agencies available for SIS research, as described in the national reports, but it should be noted that these primary funding agencies in some cases administer a number of programmes related to SIS research. However, the general tendency among these countries is that funding programmes are only accessible to a limited degree, and that resources for SIS research are generally scarce. UK and Germany are salient exceptions. According to the national correspondents, research focused on the interplay between science and society is highly prioritized in both countries. UK and Germany are also part of the small group of countries, in which non-profit private sector foundations support SIS research.

Figure 11 Funding agencies targeting SIS research; no. of references



Conversely, 18 country reports state that no funding programmes specifically targeting science in society issues exist. These are widely dispersed across Europe and include among others Ireland, Israel, Sweden, Italy, Spain, and Luxembourg. Additionally, several Eastern European countries seem to suffer from a lack of funding schemes available for SIS research as well. For some of these countries, funding schemes have been announced but not yet implemented. Instead, research related to science in society has to be financed through other funding channels, for instance through institutional funding (e.g. ministries, research institutes) or project funding (e.g. national funds). SIS research can also be embedded in projects which do not have SIS related topics as the main priority and thus be included in generic programme funding. The Bulgarian correspondent explicitly mention that in order to carry out 'important and larger studies', funding resources have to come from abroad. This could include funding on a bilateral basis, support structures available through the EC Framework programmes or other international organizations. Similarly, it is evident for many countries that various EU funding opportunities play an important role in order to perform SIS related research.

Science in Society issues as evaluative elements for national research programmes

Different SIS issues are, to various degrees, taken into account as elements in evaluation of research proposals among the European countries, but some national correspondents explicitly state that SIS evaluative criteria only to a small degree, if at all, play a role in project evaluation. These countries include Albania, Sweden, Latvia, Norway, Romania, Serbia, Slovenia, and Italy. Still, various specific criteria are highlighted by most correspondents as relevant to the assessment of research proposals. Several criteria are mentioned in the national reports, and six main themes can be identified as shown in figure 12 below.

Figure 12 Thematic SIS evaluative criteria for the assessment of research projects

Research careers

12 countries report that issues relating to research careers of female researcher are taken into consideration when evaluating research projects. This includes, for instance, the implementation of specific programmes aimed at increasing the proportion of women in science. However, the extent to which gender equality embodies a real threshold element in the evaluation seems to vary between countries, with some countries merely treating the issue as a ‘tick the box’ criteria. For some countries, such as Austria, Germany, the Netherlands, Switzerland, and Denmark, measures to promote women in science are included in the evaluation structures of research councils, whereas other countries, such as the Czech Republic and Lithuania, report that gender balance issues are merely superficially taken into consideration during the selection process. Also relating to human capacities in research several countries state that specific programmes for stimulating the careers of young researchers are launched and specific evaluation criteria assess whether junior researchers are included in research projects. Only Cyprus, Israel, and the Netherlands report of evaluative criteria aimed at promoting minorities in science.

Communication & dissemination activities

Activities related to science communication and dissemination are emphasized by 12 of the national correspondents as being important evaluative criteria for project assessment. This tendency is evident across Europe. Explicit communication strategies in terms of public outreach and dialogue, for instance in order to promote scientific cultures, are, in several cases, included in the evaluative criteria. Furthermore, strategies for the dissemination of research results are in some cases mandatory and in other cases encouraged in calls for research programmes and projects. In accordance with the objective of communicating research results to the broader public, a few countries also mention criteria such as; a ‘clear and understandable language’, ‘management of research data’ and ‘open access to research results’ along with ‘considerations from the perspective of end users’ as evaluative criteria implemented in research calls.

Ethics

Ethical aspects and ethical implications of proposed research projects are mentioned by several correspondents to be a matter of consideration in assessment of research, and especially within the area of bio-medical research.

Risks and sustainability

This rather broad category incorporates matters and criteria related to risk management and sustainable living. In regard to the latter, evaluation criteria most often focus on environmental sustainability and environmental impact. Despite the overall importance of environmental and climate related issues in public debate relating to SIS, and the presence of several SIS research activities in this area, only a few countries address these elements in evaluation processes.

Social relevance of research projects

Six European countries report that the social relevance and value of research projects in terms of 'societal development' are taken into account when assessing project proposals, but the information does not provide a clear picture of the actual contents of these considerations.

Inclusion of stakeholders and cooperation between science and industry

A small number of countries highlight that cooperation between science and industry is considered important as an evaluative element in project evaluations. Furthermore, Austria and Sweden note that the inclusion of a wide array of stakeholders (beyond 'industry') is taken into consideration when reviewing project proposals.

A graphical presentation of the distribution of countries within each category is given in Figure 13 below.

Figure 13 Distribution of countries within the thematic SIS evaluative criteria for the assessment of research projects

The relative weight of SIS criteria compared to other evaluative criteria

As described above, SIS criteria are more and less formalized and more or less explicitly included in assessment processes. The picture is rather diffuse with regard to the extent to which SIS criteria on a more systematically level are taken into consideration. This is the case both across and within countries since different funding programmes, also within countries, can differentiate in terms of the criteria applied. Some countries draw attention to the fact that SIS evaluative criteria have increased in importance; however compared to other evaluative criteria, the general consensus is that more traditional criteria such as the 'scientific quality and originality of project' and 'stringency of the argument' remain significantly more important than SIS evaluative criteria. With regard to the relative importance of SIS criteria *vis-à-vis* other SIS criteria, it seems, as outlined above, that issues related to science communication- and dissemination activities, along with research careers and more specifically, the promotion of women and young researchers in science, are applied more often than others. Gender and age related criteria tend to embody real threshold elements in some countries whereas in other countries they merely function as 'tick the box' criteria, and can be compared to other types of background information.

3.4 Science communication activities

A separate section in the national reports revolves around national activities particularly concerned with the public communication of science and technology. The themes covered are national science communication trends and examples of good practices, young people and science education in schools, activities and practices related to science journalism, and the current status and use of specific science communication activities, e.g. TV-programs, popular science articles, festivals, museums, and other types of media. In the following, these activities will be reviewed, common trends and characteristics will be highlighted and national and regional differences will be discussed. In the second part of the section some recurring parameters are introduced and used to characterize specific groupings among the 37 countries covered in this final MASIS synthesis report.

National science communication trends

A notable common trend is that the efforts and attention paid to science communication in general and communication aimed at young people in particular is on the rise in most of Europe. Governmental initiatives aimed at strengthening communication from scientists to the public are numerous and also the number of non-governmental actors involved in this type of communication is increasing. Many reports indicate that both universities, governmental agencies, non-governmental organizations, professional and private organizations play a major role in the overall communication of science and technology, and contribute to a more complex and diverse science communication practice in the participating countries. The proliferation of new actors in science communication is accompanied by new formats for communication. The examples of 'good practices' are equally numerous and especially large scale events, such as science festivals, and institutional events, such as Open Days (or Nights) at universities and other research institutions, are widely mentioned as successful initiatives.

According to the national reports, there are several reasons for the growing use of and attention to science communication. Some reports mention the financial crisis as a motivational factor, and others highlight the serious shortage of young people interested in pursuing a career in science and technology. Especially the latter explanation seems to be a consistent concern for governments and civil society organizations alike, and it has had a significant influence on the development and implementation of initiatives in this area. In the list of good practices there is a noteworthy amount of projects aimed at strengthening the interest of children and young people, involving a broad variety of formats including science festivals, children's universities, science contests for students, and many more.

The national correspondents were specifically asked to consider the intensity of coverage through a range of different media, and in this regard the reports show a more varied picture. Some report on decreasing intensity, especially in the traditional media types, e.g. newspapers, radio and TV, while others mention an increase in science coverage in these media. However, looking at the average evaluation of trends in the respective influence of different communication channels (TV, Radio, Newspapers, Magazines, Large Scale Festivals, Web, Museums / Exhibitions, Citizen- or CSO initiatives), all these media, except from radio, are on average considered more influential means of science communication than they were 5 years ago.

Increased use of new media formats

Particularly, the national reports stress increasing use of new media formats in the communication of science and technology. All countries except Macedonia, Slovakia, and Slovenia report that web-media has become ‘more’ or ‘much more’ influential during the last 5 years. This tendency is particularly strong in South-Eastern Europe and less significant (but in no way absent) in Central-Western and Central-Eastern Europe. This increase in the significance of new media types clearly affects the accessibility of scientific information and many correspondents do indeed report on increasing opportunities for the public to gain access to information about science and technology, but there is also an increased awareness that this accessibility does not necessarily foster knowledge or even interest. Potentially there is a risk of information overload. If the public at large as well as targeted segments of the public are unable to navigate and select among multiple sources of scientific information, accessibility may come at the cost of clarity and quality.

This increasing importance of web-based media for science communication has stimulated developments also in the traditional media. While several country reports indicate a decline or stagnation in the relative importance of the more traditional media formats, such as newspapers, radio[17] and television, it does seem that in some countries the more traditional media types have met the challenge by reconfiguring their coverage of scientific issues to suit the new communication agenda – in many cases to the detriment of the ‘classic’, in-depth and nuanced science journalism. Several national correspondents report on a decrease in the quality of the scientific coverage in these media.

[17] A notable exception to this trend are the Nordic countries where also radio as a medium for science communication has become more influential over the past 5 years, and where new TV programmes have been mentioned as successful examples of science communication.

Young people and science education in schools

In the MASIS template, correspondents were asked to describe recent initiatives and activities related to science education in schools and other activities aimed at young people – both in regards to developing skills and interest in general, but also concerning particular examples of initiatives aimed at stimulating critical reflection over the role of science in society and societal issues.

The general trend is that there are many initiatives and activities aimed at young people – both institutionalized in (natural) science education in schools, and also extra-curricular activities such as science festivals and TV-programmes seem to be on the rise. However, the main bulk of activities aimed at stimulating interest is organized in the context of the schools and often in the form of specific programs where students come into contact with scientists or scientific processes via visits to research centres, universities, or scientists visiting schools. Another tool to enhance the skills and interest of school children that seems to be gaining popularity is arranging contests where students compete on ideas, skills and creativity. These competitions are widespread and very diverse, as they cover not only natural science, but also cross-disciplinary issues and themes. Good examples of such competitions are e.g. *Jugend Innovativ* in Austria, where students compete on innovative ideas in business and design as well as engineering, science and environmental protection. In Croatia, students compete in robotics (*Robocup*), and in Liechtenstein young people are encouraged to post their innovative ideas on a website, promote it on e.g. Facebook and Twitter and subsequently collect as many votes as possible with the aim of being invited to 'Ideencamp' at Liechtenstein University.

Gifted students and girls

Several countries are focused on 'gifted students'-initiatives (e.g. Israel, Estonia, Latvia, Montenegro, and Turkey) and the increasing use of science competitions mentioned above could also be seen as aimed at youngsters with a specific aptitude for science. However, there are fewer examples of initiatives aimed at the general youth population. Some countries also report on special initiatives aimed at fostering interest in science and technology among young girls, as a consequence of the shortage of female applicants to the natural science higher education programs which is widely reported across Europe (see e.g. the ROSE project: http://roseproject.no/index.html). Examples of countries that specifically mention activities that aim at stimulating girls' interest in science and technology include Ireland, Austria, and Finland.

There is some variation in the target groups of the national initiatives, in terms of the age group/school level the activities are directed at. Most countries report on events and initiatives directed at secondary school level (teens/late teens), but some countries also mention initiatives and strategies aimed at primary school level and even kindergarten level (pre-teens) (e.g. Austria, Bulgaria, Finland, France, Norway, Portugal, Switzerland).

Critical reflection

The marked attention paid to young people and their skills and interest in science technology is to a lesser degree accompanied by activities aimed at fostering critical reflection on the role of science in society and societal issues. Very few countries report on organized and institutionalized activities related to societal issues and critical reflection – and those who do often emphasize that the efforts are scattered and frequently lack significant impact on the target group. As the correspondent from Luxembourg notices, the lack of critical reflection on the impact of science on society, and on ethical issues, may be based in the underlying goal of attracting more young people to the scientific disciplines mentioned above. Along the same line other reports stress that communicating the uncertainties of science and technology goes fundamentally against the established models of dissemination. In other words, the key is 'selling science' and therefore critical reflection on how science and technology influences society is placed in the background.

Science journalism and science communication training

The national reports also include a description of activities aimed at improving science journalism and other training activities related to science in society. A striking common trend is the reported shortage in trained professional science journalists. Some countries do have actual science journalist training programs, but very often the formal training is limited to non-mandatory courses in the general journalist training programs or non-institutionalized courses or workshops organized by private organizations or associations.

The science journalist associations mentioned in the national reports are often subdivisions of larger general journalist associations or very small.

The Hungarian correspondent, e.g., reports on a science journalist club with approximately 50 members and Estonia's science journalist association counts as little as 16 members. There are also examples of larger and more organized science journalism associations, primarily in the larger Western-European countries, but the tendency towards few professionally trained science journalists and low professional support and training for them stands out clearly in the material. The lack of training of science journalists has a noticeable impact on the relationship between the academic community and the media in general. Many national reports mention that scientists regard journalists as superficial and sometimes even pseudo-scientific. On the other hand journalists often consider scientists to be uncommunicative and incapable of explaining their work in terms understandable to the broader public. This latter observation however is put into perspective by a budding trend towards increasing attention to the need for training of scientists. Many universities, private organizations and NGOs are offering courses in science communication for academic staff. They are, however, often voluntary and non-regular. Especially the British Council is perceived as instrumental in organizing seminars, workshops and programs to promote science communication among academics (and others), especially in the Eastern European countries. For students, several universities have graduate or postgraduate courses in science communication, and communication skills are also becoming an integrate part of doctoral training in many countries.

Science communication culture

Overall, the national MASIS reports represent a unique opportunity to investigate what might be called the 'science communication culture' of the participating countries. The following section will attempt to delimit such a concept by drawing out the central, recurring elements from the national reports, which have been emphasized as having an impact on the science communication situation in and across the individual countries. The relevance of pointing out central elements of such a 'science communication culture' lies in the problems outlined in the previous sections and the possible links that might be drawn between these and the 'science communication culture'. E.g. do the countries that report on decreasing intensity in media coverage of scientific issues have other, more structural things in common that might help explain such a decrease? And on the other side, do the successful – in a science communication perspective – countries have structural similarities that could act as sources of inspiration for other countries?

Main parameters of science communication culture

The MASIS-template and the scope of the present project have set up a specific frame within which the correspondents have operated. The pre-framing of themes obviously implies that some aspects have not been covered in the reports, but overall, the documentation and breadth of the material is rather extensive. In the national reports, six themes tend to crop up again and again, and these themes collectively seem to form a sensible framework for describing the science communication culture of a specific country. Below, these six parameters, which collectively form a framework for analyzing science communication culture, are presented.

1 The national science communication infrastructure: The first parameter that can be seen as an important factor in a 'science communication culture' is the degree of institutionalization or solidity of the science communication infrastructure, i.e. the number of national scientific journals, the number and regularity of science sections in national newspapers, the number and quality of science programs on national TV/radio etc.

2 Political attention: A second parameter is the level of attention paid to this area particularly from the formal political system. The reason why the political aspect is so important to science communication is that very often funding and other support for communication activities and initiatives comes from the governmental agencies, and thus a lack of attention or national focus on science communication might lead to insufficient funding.

3 The actors involved: The number and diversity of actors involved in science communication is also a significant indicator of the communication culture, as they provide an indication of the broader interest in the dissemination of science and technology. Where the previous parameter, political attention, focused on the formal system, this parameter can help determine the stakeholder situation, i.e. who feels that science communication is important to them and to what extent?

4 The academic tradition: As previously mentioned, according to some correspondents, scientists are often perceived as uncommunicative or incapable of presenting their work in a proper way. This indicates the importance of another factor, namely the national, academic tradition

for dissemination of scientific results. Some countries report on a very conventional tradition, where the primary dissemination channel is the scientific journal and the target group thus the surrounding academic community. Other countries seem to have a different tradition where science communication to the general/interested public is an integrate part of the academic system. This parameter also includes the willingness of scientists to debate their research with the general/interested public, i.e. their actual participation in face-to-face or mediated debates.

5 Attitudes towards science and the acquisition of knowledge in the public: Many respondents mention the Eurobarometer surveys when attempting to explain why the science communication of their nation does not seem up to par. This indicates a belief that the public's interest in science and ability to acquire knowledge has significant impact on the success or lack thereof of the communication efforts.

6 The science journalism situation in the country in question: As mentioned earlier, a common concern also seems to be the number and quality of science journalists, which is frequently mentioned in the country reports – also in relation to the description of the general communication situation. This final parameter thus covers the number of journalists, and their level of training and organization.

These six parameters combined provide an indication of the 'science communication culture' of a specific country. Even though they are distinct features, they are, however, not completely separable. The attitudes towards science and the interest in scientific results, for example, depend to a high degree on both science communication infrastructure and the scientific community's tradition of communicating results to the public – and vice versa.

Clustering of countries according to parameters of 'science communication culture'

When placing the participating countries in the framework outlined above a pattern arises with three distinctive categories. These three categories could be named '*consolidated science communication culture*', '*developing science communication culture*' and '*fragile science communication culture*', and they each have different characteristics with regard to the above mentioned parameters.

Consolidated science communication culture

This category comprises countries that report on intense activities or levels on three or more of the above mentioned six elements of science communication culture. They all report on a good science communication infrastructure and generally also on a high degree of political attention to science communication and many actors involved. Those countries within this category which have included information relating to the issues of the national academic tradition and the public's attitudes towards science also describe a strong tradition and a high degree of public interest in science and technology. The situation of science journalism also seems to be more positive than in the countries placed in the other clusters, with a majority reporting on a fair or high number of science journalists and sufficient professional support and training.

It is clear from the data that it is primarily western European countries which have a 'high score' on all of the above mentioned parameters. Particularly the Scandinavian countries and the larger Western European countries have consolidated science communication cultures, which is congruent with findings related to other communalities between these countries. One of the trends that additionally characterizes the countries with a consolidated communication culture, is that the emphasis on ethical and critical debates concerning science in society is more pronounced here than in the countries with a developing or fragile science communication culture. Also, there is a tendency towards more interactive activities, e.g. involving the public in the scientific process via debates, hands-on experiences with science production (in festivals and other settings), and close contact between the scientists and the public, instead of merely enhancing access to information, for example by strengthening the ICT infrastructure. Dialogical, rather than one-way, science communication, is, in other words, more outspoken in countries belonging to this category. Science centres are highlighted as successful tools in science communication to a greater degree in countries with a well-established science communication culture than in those within the other categories.

Developing science communication culture

In the second category, the common denominator is a tendency towards improvement on one or more of the above mentioned parameters. This tendency especially appears on the infrastructure factor, the political attention factor and the academic tradition factor. The countries within this category also have a medium to high amount of actors involved in science communication in common. On the more negative side, there is a marked tendency within countries belonging to this category towards having a low number of science journalists and a low degree of public interest in science and technology.

The countries in this category are primarily smaller countries and Eastern European countries. These countries could be seen as developing science communication cultures, and some of the problems they report on include the public's tendency to look beyond national borders for scientific information, either because of the relatively low scientific production of the individual country or because of a tendency within the media (newspapers, journals, TV etc.) to give preference to international scientific news.

Fragile science communication culture

All countries belonging to what we tentatively call the 'fragile science communication' cluster emphasize the poor infrastructure and in many cases also the lack of actors involved and the low interest in communication from both the academic community and the general public. Also, there is a common concern about a lack of science journalists in these countries.

This category mainly comprises Eastern European countries[18] - most from the South East part of Eastern Europe. In some reports, the relatively poor state of science communication is explained by the fact that the collapse of communism also meant a collapse of the formalized science communication structure, and a need, basically, to start from scratch. In the context of the communist regimes, there was a relatively stable communication setup, but many newspapers and journals have been forced to close due to the implementation of a market economy, which according to some correspondents has led to a more populist press. This is seen as a hindrance to a successful science communication scene.

It is striking that the countries which report on a poor national communication infrastructure also score lower on the other factors in this framework. It thus seems that the infrastructure is indeed one of the most crucial factors in the science communication culture, as it seems to significantly condition the other factors as well. Also the good practice

[18] Israel is cautiously placed in this category due to modest information in the national report.

examples from these countries seem to be smaller scale than in the countries with a more consolidated science communication culture, to the extent that such good examples can even be identified.

In figure 14, countries are tentatively placed within the framework according to their characteristics on the six parameters of science communication culture.

Figure 14 Distribution of countries on three categories of 'science communication culture'

3.5 The Fukushima accident: media debates, public involvement and policy reactions[19]

The last section of this report concerns European responses to the nuclear accident at the Fukushima Daiichi power plant in Japan, following the devastating Tōhoku earthquake and tsunami on 11 March 2011. Most people probably remember the television images of the tsunami waves pouring into coastal Japanese cities creating the largest nuclear accident since the Chernobyl catastrophe of 1986. The tsunami disabled the

[19] Responses to the template questions on the Fukushima accident from Slovenia, Israel, Italy, Spain, Albania, and UK were not submitted by mid-Dec. 2011, and are thus not included in the descriptions in this section.

cooling system of the reactors at Fukushima Daiichi, one of the largest nuclear power stations in the world, causing meltdowns that eventually led to nuclear radiation leaks and triggered a 30 km evacuation zone around the power station. The accident was assessed as level 7 on the international Nuclear Event Scale, the maximum scale value.

Across Europe, there have been substantial amounts of media coverage, public debates and policy reactions following the accident at Fukushima. European responses have been concerned with the future role of nuclear energy sources, and the accident has invoked considerable discussion related to governance of science and controversial technology, trust in scientists and expertise, and climate concerns. The interactions of public concerns, media coverage, stakeholder involvement, and policy making, provides a relevant case for exploring the role of science in society and the dynamics of responsible research and innovation. The national reports include a description of this particular topic and the reactions following the accident in terms of media coverage and public debate, the level and mode of public involvement, and the concrete policy responses to the catastrophe.

Media coverage and public debate

Media coverage was in general intense in all European countries. The Fukushima accident and subsequent consequences featured prominently in European press coverage for several months following the accident. The media coverage and appertaining public debate followed a similar pattern of journalistic focus across the European countries. Initially, the media focused on the events in Japan, the earthquake, tsunami, and the accident at the Fukushima Daiichi power plant, emphasizing factual information regarding scale and scope of the accident, aiming at illuminating immediate human and economic consequences for the Japanese population, as well as the health risks and dangers of radioactivity (contamination of air, water, and food). With regard to scientific communication and information, various experts were consulted in order to supply the more technical aspects of the accident along with exposition of the properties of nuclear power in general. The media moved from local to global effects of the catastrophe, including real and potential risks such as, for example, radioactive winds. In this regard, risks related to nuclear energy and nuclear power plants domestically and abroad (neighbouring countries mostly) were debated throughout Europe. Countries less affected by the accident, such as those without any nuclear plants, focused more on the broader European debate about nuclear energy and the policy responses in Europe in general. The Fukushima accident was continuously compared to the Chernobyl accident, particularly in those countries that were directly affected by the Chernobyl catastrophe.

A predominant topic in media coverage and public debate was that of risk; the discourses of concerns prevalent in the debates primarily emphasized the possibility of a similar accident happening in Europe and comparisons were made between Japan and Europe in terms of advanced technology, qualifications of personal etc. Safety levels in especially older nuclear plants were discussed in the light of international standards and it was questioned in several countries whether the level of control is sufficient. Moreover, the problem of nuclear waste disposals was a significant topic in European debates, as were risks related to radiation, environmental risks (spread of contaminants), economic risks (impact on electricity production and industry), among other perceived forms of risks.

Subsequently, the accident sparked broader discussion – and in several countries extensive debate – on risks versus benefits related to nuclear energy. The accentuation of these debates differed depending on existing energy policies, the general public opinion, economic considerations etc., and also depending on the different stakeholders involved in these debates, including political officials, experts, interest groups, and lay citizens. Despite varying emphases on advantages and disadvantages, the national debates generally seem to have brought similar lines of arguments into play. Proponents of nuclear energy have argued that nuclear energy is a means to secure future energy needs, can help reduce CO_2 emissions, secure energy independence (for instance from political unstable oil-producing countries), that environmental and health risks are lower than what is caused by fossil energy sources such as coal and oil, that new generation nuclear power plants are safer and that there is a lack of alternative energy sources. Opponents, on the other hand, have emphasized some of the above-mentioned risks, mainly the risks of nuclear and radiation accidents including health, safety and potentially military and security risks. Additionally, opponents have pointed to the difficulties concerning waste management and emphasized that renewable energy sources can be a way to meet international climate-and energy aims while simultaneously stimulating green growth and innovation.

Levels and modes of public involvement

The level of public involvement has varied across European countries in the wake of the accident, and public concerns have been expressed through various channels and modes of involvement. However, for the majority of European countries, the level of public involvement can be characterized as moderate or decidedly low. Public reactions have been conveyed mainly through contributions in newspapers, magazines, internet forums, and/or through small-scale events often organized by NGOs, rather than through more activist and inclusive mobilization against nuclear energy as seen in Germany and Switzerland. The Nordic countries, which historically have had strong traditions for public involvement in science and technology decision making, not least related to nuclear energy, have experienced a relatively low degree of public response to the Fukushima accident. To a certain degree, national controversies over nuclear energy seem to have come to a closure in these countries, and the catastrophe in Japan did not mobilize citizens to any significant degree. In Denmark, for instance, there are no future plans to establish power plants; rather, there is a national strategy to prioritize renewable energy henceforth, in accordance with the general public and political opinion. A relatively low degree of public involvement, based on individualized participation rather than collective action is also characteristic for countries such as Ireland, Liechtenstein and Portugal. In France, the debate has mainly taken place on a political level ahead of next year's presidential elections. For other countries, as well, the debate has primarily been played out on an 'institutional' level involving government, media, expert-, and NGO stakeholders, leaving the general public more as recipients of information than active participants. This is evident for countries such as Cyprus, Greece, Turkey, Estonia, Serbia, Hungary, Latvia, Macedonia, and Romania. For some countries the relatively low degree of public participation could be related to limited public participation in science in general, along with inclusive governance having low saliency in general. For countries such as Croatia, Lithuania, Poland, Belgium, and the Netherlands, the national correspondents also report of moderate levels of public participation, but in these countries, activist modes of mobilization, such as petitions and protest demonstrations, did occur as examples of public involvement.

In Switzerland, Austria, Luxembourg, and Germany, public mobilization has been generally strong, in advocating against the use of nuclear energy and favoring alternative energy sources - and public demonstrations, signing of petitions, along with dialogue events have taken place in order to pressure governments into closing down power plants (in own and neighbouring countries) and to strive towards future independence of nuclear energy. In Germany, an ethics committee on safe energy supply was furthermore established and as part of the committee deliberations, a TV transmitted hearing was performed in order to inform the general public in these matters.

Political responses and scientific advice

The Fukushima accident has prompted substantial policy reactions across Europe in terms of regulatory actions, revisions of energy strategies, consolidations of existing nuclear energy policies, along with policy reactions directly related to possible consequences and risks resulting from the catastrophe in Japan. In general, four main policy reactions can be identified:

Adoption and/or consolidation of anti-nuclear energy policies

In the aftermath of the accident, Austria strengthened its opposition to the use of nuclear energy, and adopted an action plan to ban nuclear energy, in order to become completely independent of this energy source by 2015. A similar political response followed in Germany, where it was decided to quickly phase out nuclear energy. Unlike Austria, the governing coalition in Germany - consisting of Christian Democrats and Liberal Democrats - changed their original position within few days after the accident, towards a phase-out in agreement with the anti-nuclear position adopted by a great percentage of the population. In Switzerland, several parties also changed their position from support to opposition of nuclear energy and a total ban on nuclear energy was suggested. However, a compromise was eventually adopted, comprising a ban of current-generation power plants, while allowing for new-generation power plants to be build - the technology for which will not, however, be available until 2040. For countries such as Montenegro, Liechtenstein, Portugal, and Denmark, the political responses were of moderate character as they only consolidated existing climate and energy policies geared towards complete independence of nuclear energy. These responses also reinforced the national strategies to prioritize investments in renewable energy sources. The political parties of the Cyprus House of Representatives unanimously passed a resolution which warned against the construction of a new power plant in Akkuyu, Turkey. In Greece, various statements on the concern for nuclear accident in neighbouring countries were expressed.

Upholding of nuclear energy investments

A number of countries have decided to pursue further nuclear energy investments and/or continue with their already established nuclear energy policies and programs. This is the case for Sweden, the Netherlands, Poland, and Romania. In France, no immediate alterations of existing energy policies have taken place. Estonia has decided to continue with its preliminary studies for constructing a nuclear power plant, and in Latvia it was finally decided (after the president changed his position) to continue the support for the construction of a power plant in Visagina, Lithuania. Turkey also carries on planning a power plant in Turkey. In Lithuania, the continuation of nuclear energy is supported as an economical and clean energy source with the added benefit of leaving Lithuania independent of Russian fossil fuel energy. In accordance with the European Commission's request to assess safety standards for the 143 nuclear reactors in the EU and national demand for taking security issues seriously, a number of countries such as France, Belgium, Finland, Romania, Hungary, and Slovakia, explicitly report of national stress tests being performed in order to check for resilience in the event of natural disasters, loss of electricity and cooling system, among others issues.

Postponement of decisions related to nuclear energy policies

In Bulgaria the decision to establish a new power plant 'Belene' has been postponed until an international, recognized consultancy has assessed whether new safety requirements have been met, and in Croatia any political responses have been postponed until the decision to construct a new power plant is discussed in 2012.

Responses related directly to possible risks as a result of the accident

In general, as a result of the accident in Japan, European governments responded to public concerns by closely monitoring the situation in Japan while providing information about potential public health implications such as risks of radioactivity, contamination of imported products etc., and official guidelines were in some cases adopted. In addition to informing on possible consequences directly related to the accident in Japan, several governments also informed on possible risks regarding power plant facilities both domestically and internationally.

The use of scientific advice and evidence as a basis for policy responses

Following the various policy responses throughout Europe, it has been discussed whether these responses reflect scientific advice and whether policy responses are in balance with scientific assessment of potential risks of accidents at European nuclear power plants. Based on the documentation provided by the national correspondents, scientific expertise was generally used primarily to explain the accident and subsequent events, and to a lesser degree, expert statements on technical and safety issues related to nuclear plants were included in decision making processes. In Germany, the decision to implement a quick phase-out of nuclear energy did include scientific advice from committees and expert hearings, in which scientists from various disciplines were involved. In their expert assessment, the participating experts considered a number of studies published shortly after the accident. The political response in Switzerland regarding the construction of future generation power plants was, according to the national correspondent, partly based on scientific advice and partly on an influential ‘populist logic’.

Scientific advice has been important, also, in decisions regarding precautionary policies, safety assessment, and stress tests. In some countries, however, questions have been raised concerning scientific objectivity, independence of scientists and process transparency, given that in some countries scientists are contractually connected to national atomic authorities and a power plant (Hungary), researchers are involved in lobbying groups which favour the construction of a new power plant (Estonia), experts are used but the public is not informed of which experts (Poland), or the public is not informed at all of whether or where in the process scientific advice and evidence will be employed (Slovakia). Furthermore, national correspondents from Bulgaria, Latvia, and Greece explicitly state that scientific advice and expert consultation have not been used as a basis for political responses in their respective countries. Clearly these issues highlight a need to discuss the roles and responsibilities of scientists, as well as transparency related to the use of scientific evidence and advice in decision-making processes.

In sum, European responses to the Fukushima catastrophe point towards important issues of science in society. The debates in Europe show the interrelatedness of discussions about the purposes and motivations for new and controversial technologies, assessment of current and future impacts, including, but not restricting to, risk analysis and management, stakeholder inclusion and the roles and responsibilities that scientists, policy makers, and the public bring in to collective reflections. European discussions questioned the adequacy of the Japanese public communication and crisis management, and pointed to the perceived lack of quick and valid information from the Japanese government and the plant operator TEPCO. Additionally, issues relating to lack of control, transparency and regulation of the Fukushima Daiichi power plant were brought up, and the accident highlights the need to provide contexts for deliberation on desired, technologically-enabled, futures, as well as mechanisms for translating these discussions into appropriate regulatory frameworks. The national policy responses to the Fukushima accident were wide-ranging, and this could provide an interesting case for further in-depth studies of the dynamics of responsible research and innovation.

4 Conclusions

The national reports emerging from the cross-European project 'Monitoring Policy and Research Activities on Science in Society in Europe' (MASIS) provide a background for analyses of trends and patterns related to science in society in Europe. The report at hand provides a series of horizontal comparisons of activities and policies across 37 European countries (one country report remains incomplete and is not included in the analyses) within a range of thematic areas, including national debates and policies relating to the place of science in society, priority setting, public participation, and governance concerning science in society, research priorities and structures, and science communication activities. The national MASIS reports demonstrate that several common features can be identified across Europe, but there are also significant differences and clustering of countries in some areas. Some of the main findings are listed below.

› Debates about the place of science in society target multiple levels, ranging from global issues of climate change and knowledge economies, over national strategies, institutional change, and the changing academic profession, to specific topical debates about controversial technologies. While the breadth of science in society is in evidence, clearly issues related to the role of science and technology for sustainable development and issues related to the governance of science are dominant among the national debates emphasized in the reports.

- The national debates are accompanied by significant policy initiatives and reforms. Intensified investments in R&D and innovation are linked with reforms of funding structures and development of performance-based models of resource distribution. Significant reforms of higher education institutions, combining increased autonomy and professionalization of management, have swept across Europe and have stimulated a higher degree of responsiveness towards societal demands, particularly in the shape of increased science – industry interaction.

- Europe is characterized by heterogeneous models and levels of public engagement in science and technology decision making. While many countries have formalized procedures and opportunities for involving citizens in priority-setting and assessment related to science and technology, the actual degree of public involvement differs significantly, and in some countries, nascent civil societies, lack of appropriate institutions, or non-inclusive political culture, form barriers for a more democratic and inclusive governance of science and technology. The issue of ‘upstream engagement’, which has some resonance at the EC level, seems to have only moderate saliency in many member states.

- Many countries experience a growing concern with developing infrastructures for feeding scientific knowledge and advice into political decision making processes. In some countries, formal procedures and institutionalization do not, however, instrumentally ensure a high *de facto* use of science-based knowledge in decision making, whereas other countries have both well-established traditions and institutions and an extensive use of science in decision making, particularly within policy areas such as health and environment.

- The MASIS reports provide a rich database of actors involved in defining the relationship between science and society within specific areas including ethics in science and technology, equality, diversity, and inclusiveness in scientific institutions, science communication, and technology assessment. The mapping of these actors depict variation across the four main areas, however, judging from the examples stated in the national reports, some actors, including governments and ministries along with universities and other higher education institutions, seem to have a leading position in setting agendas and shaping the relationship between science and society.

- With regard to research activities and priorities relating to science in society, the national reports point at significant efforts in several areas, including governance of science, public understanding of science, science communication, science education, and ethics in science and technology. Science in society is generally not considered a coherent and well-defined research field, and several correspondents note that continued research efforts related to science in society is dependent upon the EC Framework Programme support structure. Advances in the understanding of the appropriate place of science in society thus depend on a collective European commitment to supporting further research within this area.

- As a trend across all countries, public communication of science and technology is gaining attention within governments and other institutions, particularly with regard to stimulating science communication at schools and aimed at younger people in general. The number of actors involved in science communication is increasing, adding to the complexity of the field, but also involving new formats and modes of communication, particularly through web-based media but also large-scale interactive initiatives such as science festivals. Science Weeks (or –Days, -Nights, or -Months), Science Fairs, Science Centers, Festivals and major exhibitions are mentioned by almost all correspondents as good and successful initiatives, often instigated by government bodies, networks or foundations. Most good practices identified in Europe thus involve face-to-face interaction or hands-on exploration of science, but there are also several examples of successful communication in traditional media such as TV programs, radio shows or public lectures/presentations.

- An area of concern in many European countries is the lack of qualified science journalists. Some countries have established science journalist education programs, but more often training of science journalist takes the form of voluntary courses or sporadic workshops. Also the professional support system for science journalists, i.e. science journalist associations, is underdeveloped in most countries. There is, however, a nascent trend towards increasing training activities for scientists and students in science communication practices.

- Based on six parameters of science communication activity, a framework for assessing and categorising 'science communication culture' was developed. Three distinct clusters of countries were identified, namely countries with a 'consolidated', 'developing', and 'fragile' science communication culture. Within each of these categories, countries display similar characteristics and report on similar challenges. Science communication culture tends to interconnect also with issues related to governance of science and public involvement in science and technology decision making.

- The nuclear accident at Fukushima Daiichi has caused substantial amounts of media coverage and public debate across Europe concerning the future role of nuclear energy sources. Issues related to the impacts of controversial technologies, prominently risk implications, governance of science, trust in scientists and expertise, and public involvement in science and technology decision making have been key in these debates. The Fukushima catastrophe has also prompted substantial policy reactions across Europe. While some countries have consolidated their energy strategies in the wake of the accident, other countries, such as Austria, Germany, and Switzerland, have implemented or decided on policies radically affecting the status of nuclear technology as a future energy source.

- The main result of the MASIS project is the establishment of an extensive, validated, and easily accessible database with information on issues pertaining to science in society across Europe. Each of the 37 national reports available at www.masis.eu offers an extensive insight into national activities and policies related to science in society, and, in combination, the reports provide an invaluable reservoir of information which, we contend, will allow for further research and analyses of the role of science in society in Europe.

5 Recommendations

In combination, the 37 national MASIS reports and the cross-country comparative analyses presented in this final synthesis report, provide a picture of Science in Society as a vibrant political and academic domain, with both distinct national profiles and trajectories on the one hand, and a number of common trends and issues on the other hand. The objective of the MASIS project has been to map or monitor policies and research activities, and while the complexity and multilayeredness of this field is clearly in evidence, some general observations might translate into tentative recommendations.

1 The adequacy or appropriateness of science in society cannot be satisfactorily assessed on the basis of singular perspectives or criteria. The dimensions relevant to discussions about the appropriate place of science in society stretch from global to local concerns and include not only issues related to risk or ethics, but a range of other environmental, social, economic, and cultural components. It would be useful if future activities and studies within the field of science in society could explore *integrated* approaches to science and technology assessment, where multiple components are taken into account, including assessment of the anticipated and wider environmental, economic, ethical, social, and cultural impacts of scientific and technological developments.

2 Discussions and processes relating to assessing the appropriateness of science in society should be inclusive and based on broad public and stakeholder engagement. The national MASIS reports clearly show that the degree of success in ‘opening up’ such process vary significantly across Europe, and that formalization or institutionalization of public engagement does not guarantee a high de facto degree of public participation. As the 2012 SiS Work

Programme rightly notes, 'the Europe 2020 societal challenges can only be tackled effectively if society is fully engaged in science, technology and innovation', and it should be stressed that the dynamics of public and stakeholder engagement remains an important object for further research and experimentation.

3 Europe has witnessed extensive policy developments relating to the place of science in society, particularly concerning the interaction of science and industry, and significant attention has been devoted to creating structural conditions at research institutions that stimulate societal responsiveness and innovative capacity. As the 'Innovation Union' Flagship Initiative clearly underlines, research and innovation are key drivers of competitiveness, jobs, sustainable growth, not least in a context of financial crisis and increased global competition, and it is useful to note the pivotal importance of understanding the processes that lead to sound decisions about research, innovation and scientific institutions, i.e. understanding the governance models of science and technology. In both public debate and SiS research at the national level, governance issues play a dominant role, and it is advisable to support continued efforts within this area.

4 As a research field, Science in Society is characterized by complexity and heterogeneity, and the national systems for supporting research activities within this field differ significantly. Several correspondents note that continued research efforts related to science in society is dependent upon the EC Framework Programme support structure. Advances in the understanding of the appropriate place of science in society thus depend on a collective European commitment to supporting further research within this area, also within the new structure of the Horizon 2020 framework.

5 The main result of the MASIS project is the establishment of an extensive, validated, and easily accessible database with information on issues pertaining to science in society across Europe. Each of the 37 national reports available at www.masis.eu offers an extensive insight into national activities and policies related to science in society, and, in combination, the reports provide an invaluable reservoir of information which, we contend, will allow for further research and analyses of the role of science in society in Europe. It is recommendable that focused research activities, in which the MASIS

reports are used as empirical information, are encouraged, and that the MASIS material is made available to the SiS scientific communities as well as national and European stakeholders and decision makers.

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