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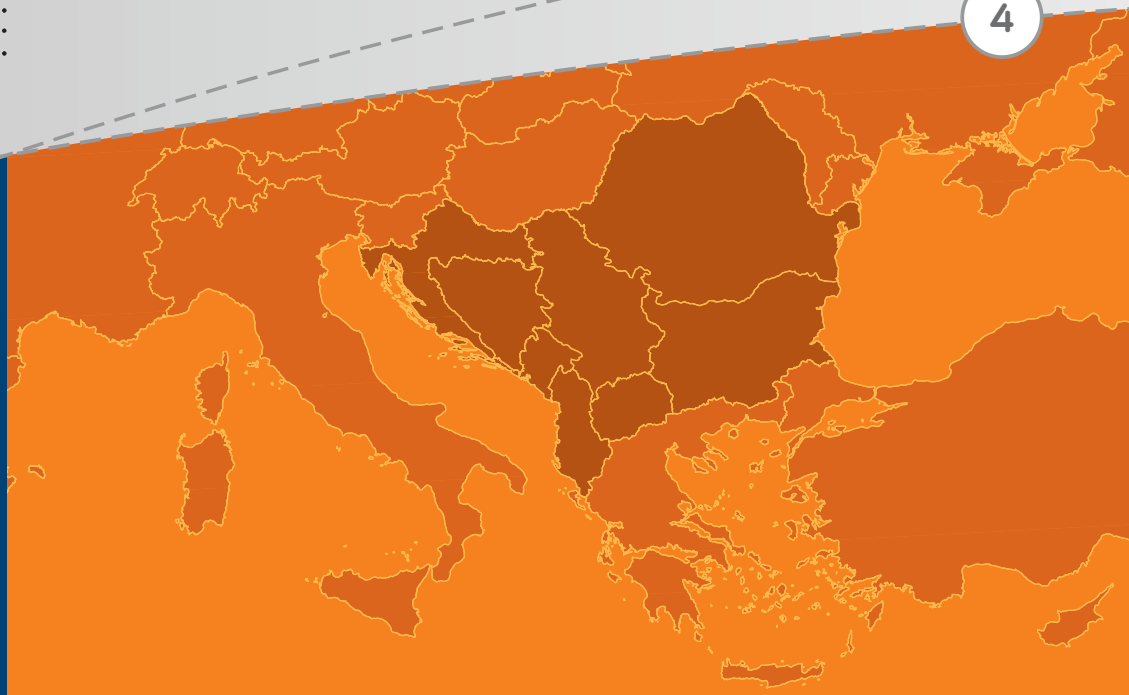

Enhancing Science Policy and Management in South Eastern Europe

Science and Technology Statistics and Indicators Systems

United Nations
Educational, Scientific and
Cultural Organization

UNESCO Office in Venice

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N°4

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This Report was written by Tiago Santos Pereira of the Coimbra University in Portugal on the basis of a series of fact-finding missions and extensive discussions with national experts conducted, on behalf of UNESCO-BRESCE, in October and November 2005, and February 2006, in several of the countries of South Eastern European region.

Many thanks to all professionals who have participated in the discussions and consultations and have provided valuable information for the elaboration of this publication.

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Foreword

Reliable and timely statistics and indicators are essential tools for informed and accurate decision-making. They are needed in order to measure progress, analyse trends, forecast future needs and focus resources. Recent advances in information technologies have raised expectations among users to have quick access to statistics and indicators. Data quality and comparability are however, in many cases, uneven.

In the case of science and technology (S&T) indicators, the need for improving their collection, processing and dissemination in the European countries in transition was emphasized on various occasions. That is why, through this Report, the UNESCO Office in Venice – Regional Bureau for Science and Culture in Europe (BRESCE) encourages Member States in South Eastern Europe to adjust their national systems to European and international standards by identifying gaps and providing a series of comprehensive recommendations.

We are convinced that the stocktaking provided in this publication will contribute to recognize the importance of the readily available S&T statistics and indicators for decision-making, as well as to reinforce the sub-regional co-operation in this specific field. UNESCO BRESCE, in co-operation with the UNESCO Institute of Statistics in Montreal, is willing to further assist South Eastern European Member States in this challenge.

Engelbert Ruoss
Director UNESCO Office in Venice

List of Acronyms

CARDS	Community Assistance for Reconstruction, Development and Stabilisation
EU	European Union
EC	European Commission
ESS	European Statistical System
EUROSTAT	Statistical Office of the European Communities
FTE	Full Time Equivalent
GDP	Gross Domestic Product
GERD	Gross Expenditure on Research and Development
HRST	Human Resources in Science and Technology
ICT	Information and Communication Technologies
ISCED	International Standard Classification of Education
MBP	Multi Beneficiary Programme
OECD	Organisation for Economic Co-operation and Development
RDI	Research, Development and Innovation
R&D	Research and Development
SEE	South Eastern Europe
STA	Science and Technological Activities
S&E	Science and Engineering
S&T	Science and Technology
SNA	System of National Accounts
UNESCO	United Nations Educational, Scientific and Cultural Organisation

Preface

The present Report presents the results of a Pilot Study on '*Enhancing Science Policy and Management in South East Europe: S&T Statistics and Indicators Systems*', I have conducted on behalf of UNESCO Office in Venice - Regional Bureau for Science and Culture in Europe (BRESCE). It consists of two main deliverables. The first deliverable corresponds to the main part of this Report. Following the Terms of Reference it consists of "an analytical report concerning the state of the art of the production (from the qualitative and quantitative points of view) of S&T statistics and indicators" in Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Former Yugoslav Republic (FYR) of Macedonia, Montenegro, Romania and Serbia; and a project proposal for future activities to be undertaken in this area.

To this end the study entailed undertaking field missions to five[1] of the mentioned countries (Bulgaria and Romania were not visited, because of the existence of additional relevant desk information deriving from their more advanced accession phase to the EU), where consultations were held with relevant policy-makers, at the Statistical Offices, traditionally in charge of producing this data, and at the Ministries in charge of science policy, main users of this data. Three main field missions were undertaken, at the end of October, at the end of November 2005, and during February 2006, to the mentioned countries. Further material was collected on the basis of desk research, in addition to the information collected during the consultations.

From the analysis presented here and the concluding recommendations a second deliverable is included here, in Appendix. This consists of a project proposal for future activities to be developed towards the strengthening of the capabilities of the S&T statistics and indicators systems in the study countries.

The interest and openness demonstrated by all interviewees is gratefully acknowledged, and contributed very significantly to the conclusions presented herewith.

Finally, the support and encouragement of Iulia Nechifor, programme specialist of the UNESCO Regional Bureau for Science and Culture in Europe (BRESCE), has been much appreciated.

Tiago Santos Pereira

[1] During the mission to Serbia and Montenegro, prior to the referendum that led to the separation of the two nations, visits were made only to institutions of the Republic of Serbia, due to logistical constraints, but further enquiries were made on the initiatives at the Federal level and information was collected on the activities within the Republic of Montenegro.

1. Introduction

Across the world economies and societies it is now widespread that knowledge is one of the main resources for social and economic development. In this context, science and technology (S&T), through the production of new knowledge, the training of highly qualified personnel, and its impact in the development of technological innovations, take a central role in the future competitiveness of the world's countries.

From a policy perspective, the existence of a dedicated set of indicators on these activities is of particular importance for making informed decisions about the organisation of the S&T system and the strategies for its development. These can contribute to provide detailed information to monitor activities in this field and to take the necessary policy options. In this way, S&T statistics and indicators have increasingly been gaining relevance across policy circles and increasing importance among the wider set of official statistics.

With its origins during the beginning of the 20th Century, and with the principle international developments during the 1960s, this policy network involves different national and international organisations.[2] Among the latter, UNESCO has had a very important role in the initial development of S&T statistics, and, particularly, in implementing and disseminating these methodologies and standards and compiling data with the objective of providing extensive world coverage. Other international organisations have also had a particularly important role, namely the OECD, which has developed the standard surveys for the collection of R&D data, the 'Frascati family' manuals, and the European Commission, through EUROSTAT but also through activities in the Directorate-General for Research, which have recently played a central role in Europe, where S&T have become central to its development strategy, known as the 'Lisbon Agenda'.

While most European countries have been either members of OECD or the European Union, or members of the European Economic Area, and as such have participated in different processes and discussions in the development and implementation of the main statistical methodologies and new indicators, some European countries have been out of this process.

The present Report analyses in particular the status of production of S&T statistics and indicators in seven countries of South East Europe (SEE): Albania, Bosnia & Herzegovina, Bulgaria, Croatia, Former Yugoslav Republic (FYR) of Macedonia, Montenegro, Romania and Serbia. These countries have some significant differences between them, but are all, in a more factual or more potential way, in a process of accession to the European Union. Bulgaria and Romania are

[2] This will be further discussed in the next section. For a detailed historical analysis of the development of statistics in S&T, see Godin (2005).

already members of the European Union.[3] With official candidate status granted to Croatia since June 2004, the EU has recently launched the corresponding accession talks.[4] Candidate status has recently been granted to FYR of Macedonia.[5] Albania has just signed with the EU, in February 2006, a Stabilisation and Association Agreement. Bosnia and Herzegovina is negotiating a similar Agreement, and Montenegro and Serbia are preparing to initiate the same process.

The post-transition process has focused mostly on the need for the stabilisation of democracy, macro-economic dynamics and internal security. This is also reflected in a greater emphasis that is placed, from the policy-making point of view, on the corresponding statistics. In this framework, where S&T are, presently, a marginal concern in these countries, there is still little investment made in the development of S&T statistics and indicators. Under the Accession Process, or under the Stabilisation and Association Process, all these countries have benefited from support from the EU through CARDS[6] or other assistance programmes. While these may include projects supporting the modernisation of statistical offices and their procedures, typically these do not privilege S&T related statistics.

In fact, UNESCO's collection of statistics from these countries has not always been successful. In a recent study of S&T and economic development in the area, Uvalic reported:

"A general problem that should be stressed from the outset is that statistics on some key S&T indicators in the SEE countries are not readily available. On the one hand, SEE countries' isolation during the 1990s has also meant their non-inclusion into publications of major international organisations, including those of the EU and of other organisations that usually publish data on S&T. Although the renewal of interest in the SEE region after 2000 has also meant a substantial improvement regarding available international sources of statistics on SEE, some of these countries still today are not systematically covered and included into the most important international publications and data bases. On the other hand, SEE countries' national statistics are presently in a process of transition, and frequently still do not include all the relevant S&T indicators." (Uvalic, 2005: 12)

This Report addresses precisely this border area. When the SEE countries are entering a process of accession to the EU, not only the EU enforces the need for statistical procedures to correspond to European and international standards, but S&T statistics in particular will also need increased visibility when political agendas adopt more forcefully the objectives of the EU Lisbon Agenda. The recognition of the role of knowledge producing activities, in particular through S&T, in that process has to be reflected at the statistical level too. As such, from the point of view of these countries, **S&T statistics will be necessarily an area that will require**

[3] Bulgaria and Romania have signed the Treaty of Accession on 25 April 2005 and became members of the EU on 1 January 2007.

[4] It should be noted that the first chapter under negotiation was precisely that of 'Science and Research', which led to the signature, on 18 November 2005, of a Memorandum of Understanding between Croatia and the EU on the association of Croatia to the 6th Framework Programme for Research and Technological Development of the EC.

[5] Council decision of 17 December 2005.

[6] Community Assistance for Reconstruction, Development and Stabilisation (CARDS).

increased attention in the future. It is hoped that this study can contribute to that process and to highlight possible directions for future development.

This study of the state of affairs in this area includes some relevant contributions which are significant not only to the local actors, but also to international organisations, and to UNESCO in particular, regarding further action. Necessarily, although the local situation in other countries may differ, some conclusions and recommendations will also be relevant for actions in other countries.

It should be noted that this Report is the result of a limited Pilot Study of the topic. It is not expected to be an endpoint, nor to be "too conclusive" about the state of affairs. For example, it does not present detailed data comparisons as one objective is to distinguish clearly between the organisation of the production of statistics on S&T (the main focus of the study) and the decision-making process on S&T policy, the latter being more intimately linked to the data comparisons. Of course, as will be further discussed in Section 2, these are intimately related. But the conclusions to be derived from such international comparisons are properly in the realm of S&T policy. Entering into those areas of discussion could distract the reader from the main objective of the Report, i.e. analysing the production of statistics and indicators in this area.

Necessarily, the organisation of the S&T system and the directions of S&T policy in these countries are relevant. These will be discussed briefly in Section 3, but mostly from the point of view of the actors involved in the S&T statistical system. Statistics do not stand alone. They derive from different actors' activity and are also used by them.

As such, the Report is organised in the following way:

- **Section 2** presents an overview of the main statistics and indicators in science and technology, their development, main actors involved, and their linkage to science policy issues;
- **Section 3** briefly describes the context of S&T research systems in the study countries, and present some brief indicators, benefiting already from a detailed study by Milica Uvalic (2005; limited to the five Western Balkan countries), recently published by UNESCO;
- **Section 4** discusses the organisation of the S&T statistical systems in these countries, the different actors involved, and assesses its limitations and needs;
- **Section 5** presents the conclusions and main recommendations of the study.

With the objective of contributing for the improvement of the S&T statistical systems, a Project Proposal for the strengthening of capabilities in this area can be found in the Appendix to this Report. Further detailed information is available in the enclosed Annexes.

2. S&T Statistics and Indicators

With the growing relevance being given to the role of knowledge in development processes worldwide[7] there has been, at a par, a growing emphasis on the need to have adequate tools to better understand these processes. Science and technology (S&T) activities are of major importance in these processes. Although they are by no means the only knowledge-producing activities, S&T provide the main knowledge base which is used in the most diverse activities and innovation processes.

The analysis of S&T, through dedicated statistics and indicators, has already a significant historical trajectory. In a recent publication, Benoît Godin (2005) has provided a central contribution to present and analyse this historical development. Despite this process, this is clearly a still evolving area, with different users, and among these policy-makers in particular requiring new types of indicators to address such a wide ranging domain. While this is partly linked to the expanding notion of knowledge-producing activities, it is also linked to the wider changing mode of production of knowledge, which Gibbons *et al*. (1994) have characterised.

In the context of this report one has to be aware that the scope and reach of these changes is not identical worldwide. Much of recent analysis of knowledge dynamics, or of knowledge metrics, have been founded on the dynamics of the most advanced economies, precisely those which have not only been most successful in producing and using knowledge but also those that have seen greater changes in these activities.

In other countries, among which the **SEE countries** which are the object of this report, with primary concerns regarding social and economic stability, governments, and societies more generally, **have not been able to place S&T as a central priority of activity**. This is particularly reflected in the activities leading to the production of the corresponding S&T statistics and indicators, which have, correspondingly, not been a priority within the statistical systems. **S&T statistics and indicators cannot be seen independently from the wider context of the development of S&T policies**. Producing a reflection of the policy activity, the investment in this area reflects the corresponding policy concern.

This is a challenge for international organisations, such as UNESCO. On the one hand, these need to be actively involved in the development of new statistics and indicators, reflecting new policy needs and concerns, often arising in the most advanced economies. On the other hand, these need to guarantee the quality and comparability worldwide of existing traditional indicators, particularly relevant to characterise S&T activities in less advanced economies, less

[7] See, for example, the UN Millennium Project (2005) *Innovation: Applying Knowledge in Development*, Task Force on Science, Technology and Innovation.

based on prosperous high-tech sectors. Although from an implementation point of view these involve different concerns, these are not necessarily distinct activities.

The development of new indicators is a result of the increasing policy concern with this area. Such indicators address, for example, how different countries are faring in fostering the development of 'knowledge-based economies', in supporting activities oriented towards the production of new knowledge, and in nurturing the growth of the science and technology base, namely through the training of qualified human resources. The use and development of S&T indicators are of most importance for policy-makers worldwide. They are important to assess, through international comparisons, the performance of different countries in different dimensions that characterise the current knowledge-based economies.

Indicators are expected to better carry warnings of potential changes within society, they must be recurrent for the analysis of change, aggregate statistics, and have an underlying model of the understanding of the phenomenon at hand (Godin, 2005). While statistics leave less space for experimentation, indicators can more easily be 'created' and can thus be more easily adapted to shorter-term needs. Hence these frequently have a greater proximity to policy-making.

2.1. Role of National and International Organisations

As noted by Godin (2005), the development of S&T measurement has a long history, dating back to the beginning of the 20th century. Initially developed through the work of national organisations, mostly in the United States, Canada and the United Kingdom, S&T statistics received its main push through the work of international organisations, namely the OECD and UNESCO, during the 1960s. Later, mostly during the 1990s, the European Commission has also become an important international actor in this area.

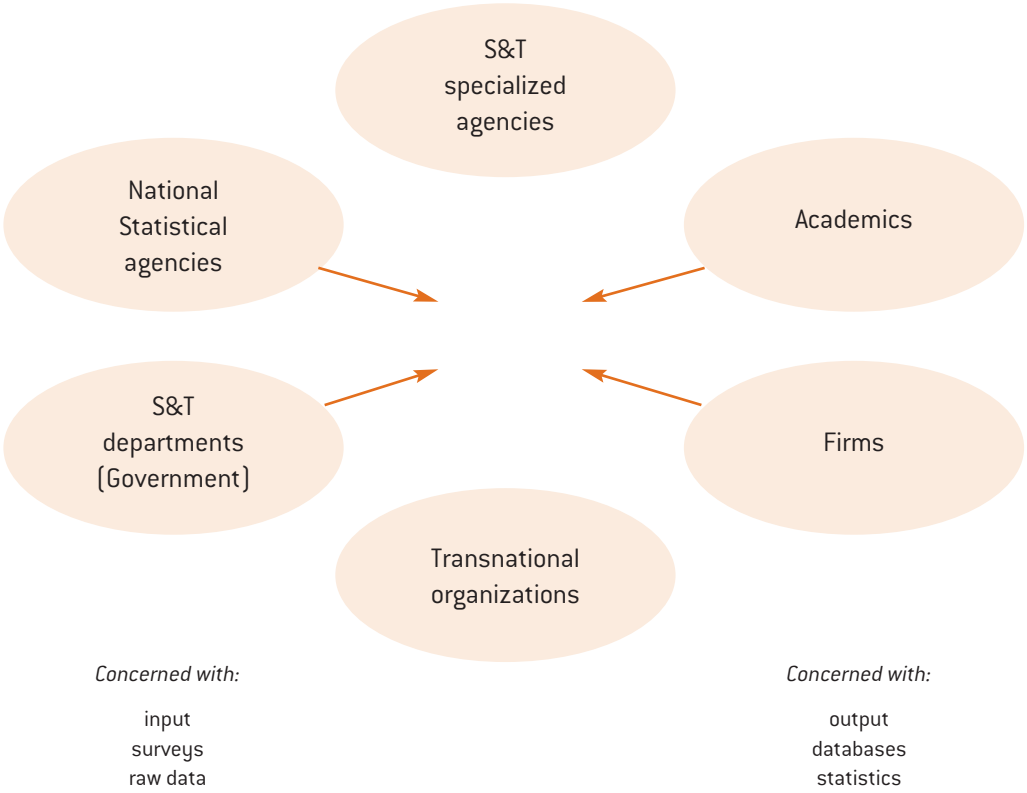
The work initially developed by the OECD, leading to the *Frascati Manual* and to subsequent manuals, also known as the *Frascati family*, has become the central standard in the area. UNESCO has also had an important role, adapting the principles of the *Frascati Manual* to a wider range of scientific and technological activities (STA), to better address the needs of its distinct users in developing countries.

The implementation of the statistical standards is left to the national statistical systems. Typically, the responsibility for collecting S&T statistics varies between the national statistical offices and the Ministerial structures in charge of science and research, depending on each country. In some cases, while the statistical office (or a delegated body) has responsibility over the collection of primary data, other offices, within the Ministry of Science or independently, develop the corresponding indicators.[8]

[8] This is the case, for example, in Norway, where an independent research institute (NIFU-STEP) produces the indicators and collects the primary input statistics in partnership with the Statistical Office, or in France, where an independent institute (OST) produces the output indicators, and the primary input data is collected by a delegated body of the statistical office, within the Ministry of Higher Education, Research and Development.

In fact, the statistical system is not subsumed within the institution producing the statistics or the indicators. As previously indicated, international organisations, in this case the OECD, the European Commission, and UNESCO, have an important input into the system, by setting international standards that allow the comparability of national data. The system also includes, besides the relevant international organisations, its different internal users. These mostly consist of the policy-making institutions, academics and firms. The following graph presents this organisation:

The organisation of the science measurement system *(source: Godin, 2005)*



As also noted by Inzelt (2005), the differences in users and their demands also contribute to shape the system of production of statistics and indicators. The extent to which the organisations producing the data find demanding users, who are able to ascribe the statistics significant priority and who contribute to improving the quality of the data produced, has an impact on the whole system.

This is of particular relevance to S&T statistics, namely in the context of SEE countries. For countries experiencing the process of transition, where S&T policy is not yet a priority area, and where the research system is still relatively weak, the statistical offices find little incentives, and support, to further develop the data, if the users do not strongly express further needs. As Fred Gault put it:

"However the statistics are produced, and the indicators derived, there has to be a user, or users, of the statistics at the end of the day. This is particularly true for science and technology indicators as they do not appear, except as expenditures, or capital investment, in the System of National Accounts, and it is the SNA which is the client for the output of most surveys in statistical offices." (Gault, 2005: 60)

2.2. Development of S&T Statistics and Indicators

S&T statistics and indicators have recently received a renewed impulse. Following a more active period of development of statistics in this area during the 1960s, which led to the development of the Frascati family of indicators, the development of the concept of the 'knowledge-based economy' has renewed the interest of national governments and international organisations in the development of S&T statistics and indicators.

It is true that such interest has never fully disappeared. Following the initial development of input indicators, the 1980s saw strong developments in the use of output indicators. Several studies emerged exploring different techniques for the analysis of bibliometric and patent indicators, the convergence of which is more widely known as 'scientometrics'. But these studies differed to some extent in that the main drivers were external users rather than governments themselves.

The 1990s saw a renewed surge in the development and use of new indicators. The development of the Oslo Manual on innovation, and subsequent work at the OECD on the knowledge-based economy, developed greater interest in new indicators to measure the 'new economy'. It was only during this period that the European Commission emerged as a significant actor in the field of S&T statistics (Godin, 2005), leading to new initiatives that spun out of the development of the Lisbon Agenda, such as the *Benchmarking of National Research Policies* (EC, 2001a) or the *European Innovation Scoreboard* (EC, 2001b and subsequent years), which have received significant attention.

Different issues should be mentioned here. Firstly, these **comparative exercises have enlarged the scope of indicators used in relation to science, technology and innovation policies**. The use of indicators such as: the 'proportion of researchers from other countries amongst researchers in universities and public research centres', the 'volume of venture capital investment in early stages (seed and start-up) in relation to GDP', the 'rate of usage of broadband electronic networks for research in R&D laboratories', or the 'share of knowledge intensive services (+ their contribution to growth) in total employment and output' for the comparative analysis of research policies (EC, 2001a) goes well beyond the typical analysis of research systems through classic science indicators, and reflects the ongoing change from 'S&T Policies' to 'Knowledge Policies'.

Secondly, **there has been a general need, from policy-makers and the academic community, to develop new types of indicators which can address some of the most pressing policy concerns**. One simple example: while data on Human Resources in S&T has been traditionally one of the central priorities for policy-makers, existing data are essentially organised on a static

perspective, of which the notion of 'headcount' is possibly the best example. However, policy-makers are increasingly requiring a more dynamic approach to Human Resources in S&T, with an emphasis on flows, subsumed under the heading 'mobility'. Mobility is of central concern at different levels. Primarily, it is used to refer to the flows of researchers between countries (in and out). This corresponds to the classic policy issue, which has re-emerged in importance across the world, of assessing the extent of the external flow of local researchers, traditionally known as 'brain drain'. From a policy perspective, this is an important indicator of the international 'attractiveness' of the country in terms of research activities, which is in its turn, a central factor regarding the national competitiveness in the knowledge economy. In other contexts, data on mobility refers to indicators of flow of researchers between different institutional settings, namely between academia and industry, or simply between different academic institutions. Such data is expected to contribute to a better understanding of the capacity of the system to foster, and tolerate (Florida, 2002) the exchange of novel ideas, through people, between different institutional settings.

Thirdly, **recent trends have seen the emergence of new composite indicators**, in an attempt to respond to the needs of policy-makers to have simple indicators available, reducing the complexity of existing data. The European Innovation Scoreboard (2001b) has been one of the primary attempts to this endeavour, introducing a summary measure for innovation, the Summary Innovation Index, which synthesises multiple indicators thus providing a clearer tool for policy-makers. Following similar concerns, other indicators have recently emerged (for a review, cf. Archibugi and Coco, 2005; for a taxonomy of innovation systems using aggregate indicators, cf. Godinho *et al*., 2005). However, different authors have warned against the dangers of misuses and misrepresentations that such composite indicators present, by reducing the complexity of the innovation process and indicators to one single figure (e.g. Pereira, 2002; Grupp and Mogee, 2004).

These developments are a challenge for worldwide statistics and indicators. It is clear that international comparisons have first to guarantee appropriate levels of comparability of data. For new indicators, this is a process that requires joint development and validation, which is difficult to attain in global terms. At the same time, improvements in the quality of existing indicators are of particular importance. This chalenge is well reflected in UNESCO's *Immediate, Medium and Longer-Term Strategy in Science & Technology Statistics*:

"The first and immediate priority in this area will be to focus on data on human resources in S&T, establishing at the same time systems of 'input indicators', including financial and institutional resources for R&D. The development of appropriate innovation indicators for developing countries constitutes the main medium-term priority for the S&T statistics programme. In the longer term, the work programme will incorporate 'output indicators' – publications and patent counts. [...] In addition, this document covers issues related to data collection, analysing the factors to take into account in order to increase the coverage and quality of the current S&T statistics database of the UIS." (UIS, 2003: 3)

This is also a particular challenge for research systems that are in the periphery of Europe, in transition from strong instability or war, and in the process of becoming, or at least being

potential candidates to become, members of the EU. As such, these different dynamics, between the short and the medium-term needs, must be a central issue of concern in the analysis of the S&T statistics and indicators production systems.

Main S&T Statistics and Indicators

It is important to identify the main S&T statistics and indicators to be considered in this study. S&T statistics have traditionally been divided between two central categories: input and output data. With the emergence of the systemic approach to research and innovation a third set of indicators, linkage indicators, that contribute to a better understanding of the processes of transformation from inputs to outputs, has emerged. Additionally, in attempts to encompass a more open definition of the research and innovation systems, and of the emphasis on policies for knowledge, the range of activities has been enlarged to better cover knowledge production activities outside the traditional R&D departments, namely in the service sector and SMEs. This also reflects the evolution of S&T policies to a wider ranging notion of 'innovation policies' (cf. Lundvall and Borras, 2004).

Input indicators include essentially two types of input resources: human and financial. These data are basically collected through a survey of performers, following the methodology set out in the *Frascati Manual*, but can also be collected through other sources, namely existing individual registries of research personnel, or through existing data at the source of the funds, rather than from the performers, although this is typically only extensively available for the public funding component (the most general level of which is the national budget – GBAORD data). The central survey methodology results in a variety of characterising variables. These include, more generally, the sector of performance, the type of activity, of a more fundamental or of a more applied nature, and scientific or technological area. Human resources data, following the *Canberra Manual*, also entail some important distinctions, namely between headcounts and FTE (full time equivalent), function (as researcher or technician), gender, education level, age. Regarding the financial data, the main additional variable describes the sector of origin of the funds spent, providing also in this way a first indication of sector linkages.

These are the classic input data, focusing on the research system and R&D activities (cf. Annex). Recent analyses increasingly attempt to include a wider range of activities, resulting in the inclusion of new input indicators and the development of existing ones. Examples of these include, in relation to human resources, a focus on the wider Science & Engineering (S&E) graduates, on life-long learning, on mobility, or in relation to funding a particular emphasis on cross-sectoral funding flows, on innovation funding/expenditures, on venture capital, or on the sectors with the highest share of investment in R&D (the so-called high and medium-high-tech sectors).

Input data are relatively well defined, but the range of output data reflects largely the underlying policy rationales. While the R&D surveys are essentially concerned with inputs (even if in some cases information is also collected on publications or research projects, as outputs), classic methodologies focus mostly on publications and patents in international databases, as the main **output indicators**. This approach reflects a view that highlights direct results of R&D, and appropriation mechanisms, but also our capacity to measure these and a focus on the

research system. Other indicators are increasingly used, with a wider focus on innovation, such as resulting spin-off firms, exports or employment in high-tech sectors, or even trademarks (cf. Mendonça *et al*., 2004).

More recently, a survey on innovation activities of firms has also started to be launched on a regular basis, following the Oslo Manual, identifying the introduction of innovations, typically a result of knowledge activities within the firm. The training of human resources is also an important result of research, raising the qualification of the labour force. As such, the number of new PhDs is also considered as an indicator of the impact of research.

Among **linkage statistics** are those that assess the extent of collaborations at different levels (countries, institutions, individuals, etc.), for example through co-authored papers, co-invented patents, cooperative research projects. It can also be included under this framework the indicators on public understanding of science, which are taken to reflect the extent of the linkage between science and society. More specifically, indicators on knowledge flows are gaining greater attention. Examples of these are citation patterns, not only between scientific publications but also between patents and publications, or, more generally, the analysis of the sources of information in the development of innovations.

More widely, **indicators on the knowledge-based economy** include indicators such as the Technology Balance of Payments, the international trade of high technology goods and services, the availability of venture capital or more generally the use of information and communication technologies.

The extent of production and use of these statistics in the SEE countries will be analysed in Section 4.

3. Research Systems in SEE

The previous section provided an overview of the system of production of S&T statistics and indicators. As also discussed above, S&T statistics and indicators are primarily directed towards policy-makers, who are their main users. The institutions in charge of S&T policy are the most important actors in this system. It is from within these institutions that many policy needs lead to the development of innovative indicators, or to the collection of new statistics. Of course, these policy needs do not appear in a void. They emerge out of the wider policy context shaping the organisation of the research system, to which they need to devise appropriate policies. In this way, policy-makers and policy-making institutions are often both the 'initiators' and 'final users' of S&T statistics and indicators.

The research organisations are central actors in the general research systems. The different types of data, also presented in the previous section, result essentially from the activity of the research organisations, who are either data providers or originators of further results, directly (such as in the case of scientific publications), or indirectly (for example, through the introduction of innovations in the economy). These research organisations can be dedicated public research institutes, but also include specific units within private business firms.

It is therefore clear that the relevant actors are those across the innovation system. Nevertheless, with the main users focused on the public policy-makers, and with these research systems more strongly focused on public sector research, in the following a brief presentation will be made of the context of the research systems in the SEE countries. Also, as will be seen in Section 4, the main available statistics and indicators in SEE are the traditional indicators, initially developed for the characterisation of the public sector research systems, rather than the more dynamic indicators that have recently emerged for the analysis of the innovation systems.

3.1. S&T Policy Framework

The organisation of the research system in all the SEE countries studied has suffered significant institutional changes in the process of transition. Nevertheless, there are some relevant differences. This process has differed from country to country. In some countries it started some time ago where in others it is more recent. It has been characterised either as a process of transition or as a process of reconstruction. The existing knowledge base was stronger in some countries rather than others and, similarly, its integration with the wider economy has reached different levels. Albeit some general common points, these are the most important differences that shape significantly the development of the research systems.

The research systems of the SEE countries are still emerging from the significant changes faced during the 1990s. Uvalic (2005) characterises the current state of S&T in SEE today, in

the light of the specific political circumstances that it faced. As a result of the break-up of SFR of Yugoslavia, and of significant political changes in Albania, Bulgaria and Romania, these countries are facing major structural constraints that strongly affect the research system. In a context of low investment, very limited attraction of FDI, and general low financial resources, the S&T system has been under the shadow of other national priorities, of greater short-term concerns, and has seen partly the dismantling of the existing knowledge base.

As Radosevic (2005: 30) discusses, these countries saw a "radical shrinking of R&D systems [...] followed by the stabilisation of relative gross expenditures on R&D (GERD) at very low levels". This led to two main developments. On the one hand these countries faced the so-called 'brain-drain', with several scientists from the existing research institutes leaving the countries in face of the 'downsizing' of the system. From a previous position of strong research quality, researchers were now being faced with a shortage of financial resources and little economic demand, able to substitute for the previous role of the state. As Svob-Dokic (2005) or Tanovic (2005) conclude, policies for human resources became a central concern in subsequent S&T policies. On the other hand, the economies were not able to move into a knowledge-based economic model, capable of exploiting the previously deployed S&T capabilities. This was partly due to the existing industrial structure, with very few large firms, more capable of significant investment in innovation activities, and to the weak linkages in the system, where SMEs have very little innovative capacity (Radosevic, 2005).

As Uvalic (2005) correctly identifies, the changes required first of all the adaptation of the existing legal and institutional framework, with the adoption of new laws on science, technology and higher education. This has also been particularly relevant to the conclusions of this study, namely regarding the country where the Law of Science had not been yet finally approved, Bosnia and Herzegovina. Under a complex model of decentralisation, with widely distributed competences regarding S&T policy, the problem of coordination, presently central in innovation policy debates, becomes particularly difficult to address. With the questioning of all previous institutional models, the implementation of new legal frameworks act as moments of clarification of existing roles and organisational models.

Across the different countries the policy paradigm is mainly that of S&T policy, rather than Innovation policy. The primary concern of S&T policies in these countries is to establish the classic models of allocation of resources within the research community, based on robust evaluation processes and internationalisation, before wider expectations can be placed upon the research system. As such, the implementation of competitive modes of funding together with evaluation mechanisms, based on peer-review, were the priority for these research systems. In this process quantitative indicators of publication outputs, from international databases, are starting to become in clear demand for policy-making. Nevertheless, the attempt to implement modern approaches to selection procedures that can induce more competitive mechanisms, supporting quality rather than favouring personal networks, or to the definition of priorities remain difficult to implement faithfully and require a process of transition (Kutlaca, 2005). The two countries in a more advanced phase of the accession process, Bulgaria and Romania, as well as Croatia, differ from the remaining, in their institutional framework, more clearly oriented towards the implementation of a full innovation policy approach.

As such, the S&T policy frameworks being implemented focus upon the implementation of National R&D Programmes that can contribute to the strengthening of the existing research infrastructure, emphasising the need for capacity building (Kobal, 2005), before moving into a model of S&T based growth. The support to the internationalisation of research activities is a clear second priority, particularly in those countries with full participation in the European Framework Programmes. Contrary to strategies followed in other countries, the support to advanced training programmes is mainly developed through the higher education policy rather than through explicit research policies.

These main policy orientations suggest that some indicators are expected to be of particular importance for policy-makers (with different degrees of coincidence with policy-makers view). These include in particular human resources, to address the central issue of capacity-building, as well as of brain drain, research expenditure data, and output data, and data reflecting the different institutional models of the university or the dedicated research institutes.

It is nevertheless clear that before S&T policy takes a wider approach through an innovation policy framework, knowledge-based and business-oriented, the research system will not have the central role in economic development that it must, and similarly, the corresponding S&T statistics will not be a priority. As a part of this process, the development of indicators on the knowledge-based economy, including innovation indicators, high-technology and knowledge-intensive business services must also become a priority, in support of existing policies.

In the sections that follow, the research systems and S&T policies of the countries studied will be very briefly presented.

Albania

The main governmental body responsible for R&D activities in Albania is the Ministry of Education and Science, providing the support for different activities and programmes, through its Scientific Research Directorate, and acting as main interlocutor with the scientific community.

The Council for Science Policy and Technological Development is the body that defines and proposes the Science and Technological Development Policy to be approved by the Council of Ministers, reviews it, and takes decisions on the National Programmes. The Council for Science Policy and Technological Development is chaired by the Prime Minister and has up to 15 members from the scientific community and governmental institutions. The main research performing institutions are universities, research institutes and research centres, the latter attached to Ministries or to the Academy of Sciences. In very specific cases NGOs can apply for public funding for research. As in other countries in the region, new competitive based funding is being the main policy instrument. Nevertheless, institutional funding remains significant, and support to bilateral cooperation is being increased.

Bosnia and Herzegovina

The complex matrix of organisation of S&T policy in Bosnia-Herzegovina is extensively analysed by Papon and Pejovnik (2006). Two main features characterise the research system and its policies. Firstly, in a marked difference to most other countries, S&T policy is imple-

mented not at the State level, but rather at the "regional" level of the Bosnia & Herzegovina Federation and of the Republika Srpska and of the ten Cantons of the Bosnia & Herzegovina Federation. This has implications in the implementation of policy, namely regarding the extent to which the funding mechanisms at each of these levels is significant enough to induce competitive behaviour, and promote quality, or to focus on building capacity. The instruments available for policy-makers are, therefore, clearly limited.

This setting has obvious implications for the production of relevant indicators (as discussed below), increased by the inexistence, at the State level, of a Science Law, defining the relevant actors and their roles, and attributing S&T policy responsibilities at the State level.

Bulgaria

The Ministry of Education and Science is responsible for R&D and educational policies. The National Science Fund, an autonomous agency of the Ministry, plays a leading role by financing research projects on a competitive basis, projects mostly developed through public research institutes, or in cooperation with business firms. It also supports the activities of international collaboration.

The Ministry of Economy is involved in the development of the high-technology sectors. The Bulgarian Small and Medium Sized Enterprises Promotion Agency (BSMEPA) provides support to SMEs. The BSMEPA has been running the National Innovation Fund, established in 2005 to finance pre-market phase product development, primarily for firms collaborating with public sector research institutions.

Croatia

The Ministry of Science, Education and Sports is the main governmental body with responsibilities for S&T policy in Croatia. The main funding mechanisms are the direct project funding, annually monitored, the funding of junior researchers in research projects, and equipment. The National Foundation for Science, Higher Education and Technological Development promotes the main calls for funding, with the aim of transforming the "Croatian society in society of knowledge". The main strategic values of these funding programmes are to underline priority to train people and nurture talent, to implement a strategic vision where innovation is at its heart, the development of new partnerships, all based on excellence as a basic principle.

The strategic focus are brain gain, ICTs, biotech, new materials and new production processes, environmental sciences and sustainable development, and a sociocultural transition from industry to a knowledge-based society.

An increasing concern, with the S&T system, has been placed on technology transfer and innovation, with the creation of the Croatian Business and Innovation Centre for these issues being a clear example.

FYR of Macedonia

The governmental body in charge of S&T policy is the Ministry of Education and Science, which has the responsibility to organise, finance, develop and promote science, technological devel-

opment, technical culture, informatics and information systems as well as international cooperation related to these issues. Research activities are performed in universities, research institutes or R&D units in industry. Other Ministries also have a significant research activity.

Several relevant laws are in place, namely those on the scientific and research activities, and on encouraging and supporting technology development. These laws define the objectives and basic principles of performing and funding scientific activities.

The Government has defined a series of programmes mainly with the objective of building capacity, through the support of R&D projects, individual fellowships, internationalisation, technological development or its infrastructure. The importance of a strong infrastructure is recognised, and is among the top priorities. Examples of this are the development of an academic research network, a library information systems, establishing technology transfer centres, etc. Cooperation with the EU in this framework has been particularly important.

Montenegro

In the Republic of Montenegro, the Ministry of Education and Science has the responsibility over science policy, following the Law on Scientific Research Activities (August 3, 1992). With low resources and a small number of researchers (less than 1000, in the latest figures), a central emphasis is being placed on the development and re-establishment of international bilateral agreements. A special focus is paid upon the University of Montenegro, as the main research institution, in maintaining and upgrading existing research potential, through funding stability, research assessment, modernisation of equipment and infrastructures and advanced training and networking (Hinsenkamp *et al*., 2005).

Romania

S&T policy in Romania is overseen by the Ministry of Education and Research, which has responsibility over the design and implementation of research and innovation policies. Other Ministries also have specific responsibilities in this area, derived both from sectoral policies or from the direct control over National R&D Institutes in their respective area. The National Council for Science and Technology Policy is a high-level governmental coordination body in charge of articulating research and innovation policies with other social and economic objectives. In addition, there are several specialised agencies responsible for specific areas of intervention (such as SMEs, intellectual property, or the space R&D programme) and advisory bodies (Interministerial level, strategy for the National RDI Plan, or for the Research Grants of the Romanian Academy, for example).

The performers are essentially grouped into universities, R&D institutes (more technologically or more scientifically oriented; under Ministerial direction or under the Academies') or firms. In addition, a number of centres or infrastructures oriented towards technology transfer have been instituted in recent years.

After a period of strong decline in public R&D investment, during the late 1990s, there has been a reversal in the trend, not least in compliance with the objectives set in the accession process, which aims to reach 1% of GDP by 2007. A central instrument for the implementation of this

objective has been the National RDI Plan, set up in 1997 and later expanded to include 10 programmes along with other initiatives of a more individual basis.

Serbia

The Ministry of Science and Environmental Protection has the main responsibilities regarding the formulation of S&T policy, with a new Law of Science in the process of being adopted. In its activities, the Ministry supports firstly basic research activities, to which the biggest share of its budget is allocated. Other areas of focus are technological development and technology transfer, international cooperation, human resources (for the first time post-doctoral fellowships are supported), and activities devoted to building the Information Society, with a focus on academic networking, IT infrastructure and e-government. The more recent interest in the development of innovation policies is reflected in the fact that a new Law of Innovation is being drafted, which will allow for the first time, for example, spin-off firms from research. The international cooperation activities have focused mostly on rebuilding bilateral agreements and on the participation in multilateral programmes, with particular attention being given to the EU Framework Programmes. One of the central drivers of change of the system has been the departure of a significant number of researchers, weakening the capabilities of the system and its innovation potential.

4. S&T Statistics and Indicators in SEE

The organisation of the systems for the production of S&T statistics and indicators varies across the world. Different actors in the research system have a role, either as producers or as users of the data, in the S&T statistical system: statistical offices, Ministries of Science, other government agencies and academic researchers. The present section will analyse the participation of these actors in the system of production of S&T statistics and indicators in SEE.

4.1. Main S&T Statistics and Indicators Producers

Albania

Statistical information in Albania is provided by the Institute of Statistics (INSTAT), statistical directorates in the districts, statistical directorates (divisions) in ministries and other central institutions, civil registration offices and legal entities and individuals.

There is, however, no clear definition of responsibilities regarding the collection of statistical data on R&D activities in Albania. The Law on Science Policy and Technological Development (Law No. 7893, 22 December 1994) defines the scientific and technological activities using the standard manual definitions, but does not attribute clear responsibilities over its statistical monitoring. While it includes in the objectives of S&T Policy, under the responsibility of the Ministry of Science and Education, to "compute public expenditure for the S&T technology" this can be considered rather as a prospective objective, as a tool for the definition of policy instruments.

The Law on the National Statistical Service does not include reference either to the collection of data on scientific and technological activities. With INSTAT having other priorities, and the difficulties the country has encountered, greater emphasis was placed on economic and social statistics, in particular regarding poverty levels. As a consequence, surveys on R&D activities were not yet initiated.

In this context, there has been no survey on scientific and technological activities in Albania until the present, even if there is an increasing interest for its development.

INSTAT has had multiple cooperation activities in different frameworks, through twining programmes, technical assistance or Multi-Beneficiary Programmes, but these have not included S&T activities. Before the signing of the CARDS Regulation in December 2000, Albania had been part of the Phare co-operation programme since 1991. The main components of the Phare and CARDS programmes consisted of assistance to INSTAT for the organisation of a population census, agricultural surveys, the revision of Albania's statistical law and the elaboration of a Master Plan (for increased capacitiy building, through the creation of a coherent statistical system

centred around National Accounts needs, as well as an improved dissemination of results). Other donors or twinning partners include Italy, Switzerland, Greece, Finland and Hungary.

Bosnia and Herzegovina

The institutional framework in the field of statistics in Bosnia and Herzegovina consists of one State office created in 1998: Bosnia Herzegovina Agency for Statistics (BHAS), and two Entitiy offices: the Statistical Office of the Republika Sprska (SIRS), and the Statistical Office of the Federation of Bosnia and Herzegovina (SOFBH).

The BHAS is supposed to co-ordinate the production of statistics, methodological issues as well as international contacts. Its main role is to produce and publish aggregated statistics for Bosnia and Herzegovina in accordance with internationally accepted methodology, based on the data submitted by Entities' Statistical Institutes.

The statistical system from Bosnia and Herzegovina has benefited from international cooperation through Phare programmes since 1996 and has been, since 2001, under the CARDS Regulation. The main objective has been to support the reform of the statistical system of Bosnia and Herzegovina, to support the development of a sustainable statistical system of BiH and to support the Agency for Statistics of Bosnia and Herzegovina and the Entity Statistics Institutes in the production of reliable, up-to-date, relevant and internationally recognised countrywide statistical data. A main part of the programme has been composed of training (English language, IT training, statistics, basic economics, demography, and national accounts), technical assistance (short-term experts in national accounts, registers and the compilation of sectoral statistics) and IT equipment. The programme also involved expert visits. Furthermore, the project assists the statistics institutes in developing relevant management and organisational know-how and updating professional skills of statisticians who will be conducting relevant surveys. These programmes have not addressed S&T activities, but rather targeted the production of macroeconomic data and the system of national accounts.

The Srpska Republic Institute of Statistics is the republic administrative institution which performs statistical activity for the territory of the Srpska Republic. Tasks and authorizations of the Institute are regulated by Law on Ministries (Official gazette of Republika Srpska, no. 72/02 and 33/04), Law on Statistics in Republika Srpska (Official Gazette of Republika Srpska, no. 85/03), Law on Statistics in BiH (Official Gazette of Bosnia and Herzegovina, no. 26/04 and 42/04).

The field of work of RSIS is regulated by Srpska Republic Programme of Statistical Surveys (Official Gazette of Republika Srpska, no. 46/05).

In the Federation of Bosnia-Herzegovina, the Federal Office of Statistics shares responsibility on the collection of statistics with sectoral bodies and organisations, for example the Ministry of Internal Affairs of FB&H, the Federal Ministry of Finance, the Bureau for Unemployment of FB&H and others.In addition, the Statistical Departments of the 10 Cantons also have some statistical roles. Nevertheless, S&T activities are under the responsibility of the Federal Office of Statistics.

The institutional organisation of the Federal Office of Statistics clearly does not favour S&T activities. Among seven different sectors, the Sector of Social Statistics has three departments, including the Department for Education, Research, Technology, Social Welfare and Administration of Justice. Among these, research and technology are lower priorities amid the recent events in the history of the country, which makes social welfare and poverty statistics, together with those regarding the administration of justice, or even education, clearly more important for policy-makers and the international community.

It should finally be noted that in a recent review of the development of S&T Policy in Bosnia and Herzegovina (Papon and Pejovnik, 2006) recommended the establishment of a Unit (or Observatory) for Science and Technology Indicators. It was suggested that this Unit should work closely with the BiH State Agency for Statistics, and assist the Council for S&T Policy in its work.

Bulgaria

Following the previous Central Statistical Office, the National Statistical Institute was established pursuant of the Statistics Act, adopted by the National Assembly on 29 July 1991. The National Statistical Institute is a State institution which carries out statistical activities in the country and provides statistical information.

The National Statistical Institute conducts statistical surveys in accordance with the requirements and resolutions of statistical organizations and other international organizations. Within the National Statistical Institute, a Supreme Statistical Council has been set up, composed of specialists in the fields of statistics, data processing and statistical information users' representatives.

The Supreme Statistical Council is an advisory body of the National Statistical Institute authorized to present opinions and provide estimates and advice relating to the plan, programmes and reports of statistical surveys, the structure of the National Statistical Institute, development trends in statistics and scientific programmes for the training and qualifying of statisticians.

One strategic priority of the National Statistical System is the implementation of the European Statistical System requirements. According to the negotiating position on Chapter 12 "Statistics", "The Republic of Bulgaria accepts and will implement in full the 'acquis' in the field of statistics. As a working hypothesis, the Bulgarian Government considers that Bulgaria will become a member of the EU on 1 January 2007. No derogation or transitional periods in this area will be requested".

The programme for the development of statistics in a medium-term perspective ensures a link between the fundamental tasks, included in the Law on Statistics, strategic policies and achieved results. Tools for its implementation are the annual national programmes for statistical surveys, adoption of the acquis, activity plans and operative tasks' plans, as well as the reports for their realization.

Croatia

The Central Bureau of Statistics (CBS) is the central statistical institution in the Republic of Croatia. The primary activity of the CBS is to provide professional services which bear upon the

preparation and carrying out of statistical surveys. Furthermore, the Bureau collects, processes, analyses, publishes and provides statistical data, as well as methodological and other professional guidelines for statistical surveys, and supervises their implementation.

The CBS is vested with the authority to prepare the Program of Statistical Surveys for the Republic of Croatia. A part of this Program is carried out by other public administration institutions which are authorised by the law. Act on Statistics is the legal and methodological bases for the determination of the statistics and statistical research, surveys, data collection, data processing and data publishing.

The Law on National Statistics has also established the Statistical Council to act as a professional body for statistical issues. Its task is to ensure the participation of scientific, professional and other public bodies in drafting the Program of Statistical Surveys and strategic development of the national statistical system, as well as the objectivity and rationality of their contents and implementation. The CBS performs statistical surveys through its district units located at the lower territorial administrative levels. It also cooperates with other government agencies which perform a part of national statistics' activities.

The Central Bureau of Statistics (CBS) has been collecting regularly R&D statistics, through an annual survey.

At CBS, R&D statistics are developed through the Unit of Education and Science, in the Department of Education, Culture and Science. However, a major limitation is that only 1 person works in the science sector, while others work with education and culture statistics. This is a strong limitation for the further development of the quality of the data and for the production of new statistics in this area. Besides the strong limitations that the statistical officer in charge of this area faces, he only devotes part of his time to the science sector. This situation limits the capacity of CBS to adequately handle the necessary statistical work demanded by international standards. Besides the production and launching of the survey and the identification of the relevant population, the collection of data very often requires personal contact. This is of particular importance for assuring the quality of the data, both due to the needs for clarifications found by the Reporting Units, or, during the processing of the data, by CBS, but also to guarantee the best coverage possible.

In addition, CBS, as an organisation, has the capabilities in this area fully concentrated with one person, and has not trained others in this statistical field. With the current officer already dividing his work between science and education statistics, it appears necessary to train others (at least one more statistical officer) in R&D statistics so that the current responsible for the area can work on further development of S&T statistics. Thanks to numerous years of experience in this field, the statistical officer can train others, while updating interest in developing further S&T statistics.

CBS has approximately 400 employees, of which about half are technical staff in the field of statistics. In addition, but under autonomous organisation, there are Regional Offices.

Under the support of the Phare Programme, CBS will undertake the reorganisation of the Regional Offices.

The Ministry of Science, Education and Sports is in close interaction with CBS regarding S&T statistics. The Ministry collects data on higher education enrolments, graduations, finance, and data on educational personnel. One adviser is responsible for producing the relevant indicators for policy-making. It must be mentioned that CBS is under the responsibility of the Minister of Science. This should be due to better guarantee the scientific quality of the activity of CBS, while guaranteeing some form of independence, typical of scientific research. Nevertheless, this privileged dialogue should contribute to make the government aware of the need to better support statistical activities in the area of S&T.

In the area of statistics there have been specific support programmes, under Phare and under the CARDS Programmes, but these have not included S&T statistics until recently. The next Multy-Beneficiary Programme (MBP) will include support for the development of the innovation survey for the first time.

There have been essentially 4 other types of international assistance: twinning programmes, for the exchange of know-how, supply of physical equipment (in particular IT), direct investments, and sub-contracting of services.

The development of S&T statistics at CBS has benefited from bilateral cooperation, namely with the Slovenian Statistical Office.

The main user of S&T statistics and indicators has been so far the Ministry of Science, Education and Sports. However, it must be noted that within the Ministry, one adviser concentrates most of the analysis of indicators. Nevertheless, it must be stressed that there are a number of other users, namely within the academic community. To name just a few, the Institute of Economics of Zagreb has been particularly active in the area of innovation studies, and has launched the Innovation Survey in Croatia (see below). At the 'Ivo Pilar' Institute, work has been developed on S&T policy. At the Central Library of the Zagreb University School of Medicine, some studies have been conducted on bibliometric analyses of the available data. It must be noted that there was a very strong relationship between researchers in the academic world and the main officials in charge of S&T indicators, both at the Statistical Office and at the Ministry of Science, Education and Sports.

FYR of Macedonia

The statistical system of the FYR of Macedonia is centralised. Statistical work is mainly concentrated in the Statistical Office (SO) and its 8 territorial departments. The SO conducts annually about 200 statistical surveys with monthly, quarterly, bi-annual and annual periodicity covering 28 areas of the socio-economic life of the country. Besides the Statistical Office, statistical work is performed by the Ministry of Defence, Ministry of Interior, Ministry of Justice, Republic Office for Health Care, Pension and Social Welfare Organisation, Employment Office and some other authorised government organs within their scope of activities. All publications by the SSOM are bilingual (Macedonian and English).

The State Statistical Office is the main entity responsible for the production of national statistical data. Its main mission is defined as to provide objective statistical information and analysis to the users (Government, Parliament and society in general). In fact its activities are directed particularly to the production of statistical data than to the production of analytical reports on the basis of such data. Generally, data is provided to a wide set of users, largely in Government departments, who develop their own more extensive analytical reports.

It collects, treats and disseminates data across the main areas of activity. It is organised according to 9 main sectors, four of which are focused on thematic areas (National Accounts; Business Statistics; Social Statistics; and Labour Market and Living Standard) and others on wider support activities (IT; Statistical Registers; Dissemination; Financial, Legal and General Affairs; European Integration and International Cooperation; and Organisation and Conduction of Statistical Surveys on the Field). These sectors are organised within different departments.

Indicative of the weak relevance of S&T in this structure, the collection and treatment of data on S&T activities in FYR of Macedonia is a small part of the Department for Social Statistics, Education and Science, within the Sector for Social Statistics (other departments within this sector being the Department for Demography and the Department for Justice and Public Standards). Only one person is dedicated to work in this area, among some 250 employees of the Statistical Office (around 180 in the Central Office).

SSOM has developed collaboration at the bilateral level with international and European organisations, in particular Eurostat, and through technical assistance. However, this cooperation has not addressed R&D statistics so far. Each mode of cooperation has different objectives. Bilateral cooperation is an important way to exchange good practices. Cooperation with international organisations contributes to gain new knowledge about innovations in statistics; for example, the collaboration with Eurostat is oriented towards the negotiation process, both in getting the methodologies to the standard level required and in supporting other sectoral negotiations with appropriate data. Technical assistance is an important complement to available budget.

Montenegro

The Statistical Office of the Republic of Montenegro (Monstat) is responsible for the official statistics of Montenegro. Statistics on scientific and research organisations are considered part of education statistics and are produced by the Department of Statistics on Social Services, also responsible for statistics on culture and art, social care, judiciary and state organization including tasks on definition of methodologies, standards and classifications.

Within wider CARDS support programmes, there have been specific actions directed at the statistical system. Monstat has recently benefited from CARDS support programme for its improvement and reform. Until then, Monstat relied to a large extent on the federal office, but with this programme it is playing a lead role in the collection and processing of statistics regarding Montenegro. This does not fully happen regarding S&T statistics, which will be a new field of activity at the level of Montenegro.

Romania

After its establishment in December 1989, the National Commission for Statistics (NCS) was mainly concerned with the setting up and operating of the national statistics system in Romania, continuing the 135 years long tradition of official statistics. The recommendations comprised in "The fundamental principles of the official statistics" were adopted at the UN/ECE 47 Session. The Government Ordinance no. 9/1992 concerning the organisation and functioning of public statistics in Romania, approved by the Law no.11/1994, sets up the main principles and provisions aligning Romanian statistics, from the legal aspect, with statistical systems of countries with a long democratic tradition. The legislation on organisation of public statistics applies to all natural and legal persons carrying out an activity within the boundaries of the Romanian territory.

The statistical system includes also the Council for Coordination of Statistical Activity, a collective statistical consultative body composed of representatives of the Government or other related agencies as well as research institutions public organisations, trade unions and the National Bank of Romania. Its main tasks are determined by Government Decision. The Council is responsible to assure objective, transparent and scientific methodologies, indicators, nomenclatures, classifications and techniques used in statistical activities. The Council approves the annual programme of statistical research carried out by the NCS, as well as other statistical activities of national concern such as: censuses, methodologies, surveys.

Serbia

The Statistical Office of the Republic of Serbia has responsibility over most statistical surveys, for the Republic of Serbia, Central Serbia and autonomous provinces.[9]

In a recent assessment from the Eurostat (2002)[10] it was concluded that the recent history of statistical activity in the country has had several limitations. These have not been simply a question of lack of financial resources, but also related to the excessive emphasis on the social sector (state enterprises and co-operatives), to the weak linkages with users, in government, in research or in business, and to the low visibility of results.

While this assessment was made considering the earlier political organisation, the recommendation for the strengthening of cooperation extended beyond the institutions with official responsibility for statistics, to different forms of cooperation, in the form of joint projects, or by sub-contracting parts of certain development project to research institutes (Eurostat, 2002: 200).

The Statistical Office of the Republic of Serbia has benefited from a CARDS action, on a Multi-Beneficiary Programme, but which did not include the S&T sector.

[9] Statistical data for Kosovo and Metohia are not available from this Statistical Office, as UNMIK, as UN representative, took over the civil administration in that region. There is a corresponding statistical office in Kosovo (the SOK: Statistical Office of Kosovo). There are 7 regional departments that ensure local data collection, and in some case data entry.

[10] This assessment was conducted on the statistical system of the former Serbia & Montenegro, which included in addition the Federal Statistical Office and the Statistical Office of the Republic of Montenegro (Monstat). As mentioned in the Preface, the initial part of this study, including field missions, was conducted before both Republics became autonomous.

At the Statistical Office of the Republic of Serbia, S&T statistics are collected through the Department of Education, Science and Technology, and Culture. Work on S&T statistics has evolved very much on an individual basis, with little external contribution. There is only one person involved in the production of statistics on S&T, and that person is not exclusively dedicated to S&T statistics, but is also working on the Higher Education data. The Central Office has approximately 300 employees, half of whom are statisticians.

Besides the MBP, the Office has also benefited from some other international cooperation programmes, often at the bilateral level. Cooperation programmes have focused more on the main issues affecting the local society at present, namely regarding economic and social stability, with a recent new Department on Poverty, but also on general education statistics.

4.2. Data Collection Procedures and Indicator Production

In this section the results from the field missions and from the analysis of available materialregarding the data collection procedures and indicator production are presented. While data is presented for each country, there are some clear differences in the level of detail. This reflects as much the insight that was made available to the author, as well as the level of detail needed to explore the quality of the data produced.

Albania

No annual survey on R&D activities has been launched until the present in Albania. Previous reporting by INSTAT, the Albanian Institute of Statistics, for UNESCO's survey has been based on estimations.

INSTAT has had priorities other than S&T after the difficult situation the country faced in recent years, with a greater emphasis on economic statistics and on social statistics, in particular regarding poverty levels, and it has not been able so far to initiate a survey on R&D activities.

There have been recent discussions between the Ministry of Education and Science and INSTAT regarding the development of a survey on R&D activities, but no progress has been achieved so far.

For a future survey, the Law on Science Policy and Technological Development is of particular reference, as it defines the different types of institutions which are part of the research system, and which can benefit from public support. Private non-profit institutes can be accepted within this framework only if they indicate the activity of research in their statutes.

In addition, the Ministry of Education and Science (Directorate of Qualifications) has created a registry of researchers, which may also be an important tool for a future survey, even if it has been recognised at the Ministry that the registry requires further quality control.

INSTAT has developed some collection of data related to S&T in response to requests from different Ministries, namely regarding technology acquisition and introduction, and estimations

of the share of institutions dedicated to S&T, as an input necessary to the preparation of the national budget in the Ministry of Finance. Through the Household survey it collects information on personal expenditure on education.

Other *ad-hoc* initiatives have been developed. At the Faculty of Exact Sciences a Professor has developed a survey regarding the share of time for research (which may be particularly useful for future implementation of FTE measures) and a wider study, including qualitative data, on the use of Information and Communication Technologies, supported by the Soros Foundation.

There has been an initiative of the Albanian Centre for Science, Technology and Innovation Policy (ACSTIP), a NGO, which has prepared a project on "Raising policy awareness on the importance of S&T Indicators and Statistics for S&T policymaking and research in Albania". Although the proposal has found good acceptance, it has not yet passed to its implementation phase due to the lack of the necessary institutional support. One of the components of this project was linked to the implementation of the Frascati Manual methodologies, including its translation into Albanian and its subsequent publication and dissemination with potential users.

At present, the Statistical Yearbook published by INSTAT does not include any data regarding S&T activities. This is now a priority for future activities at INSTAT, but this needs to be developed in cooperation with the Ministry of Education and Science who has main responsibilities over this area.

No Innovation Survey has been thus far launched. Rather than initiating a new survey exercise, INSTAT envisions that the methodology of the innovation surveys should be gradually introduced into Business Survey, although the feasibility of this procedure is questionable, taking into account the length of each individual survey.

Surveys on the use of Information and Communication Technologies have been already implemented at different levels. The use of ICTs has been surveyed through the population census (10 year period), through the yearly Household Survey and Business Survey. This is an important statistic for Albania, as it also indicates changes in the availability of communication, namely due to the use of mobile communication in areas not covered by fixed telephone infrastructures.

Other relevant data collected are related to the application of Standards and to the registration of Patents and Trademarks, which can be considered as outputs of technological activities and of innovation. These data are only collected through the normal procedures, i.e., the data are not aggregated for the purposes of presenting S&T indicators.

The Ministry of Education and Science has been preparing a Platform for Statistics, which has not yet been implemented. This could include a data on existing activities and outputs, but at the moment such data is not collected. The only data collected at present is on the National Research Programmes, which is publicly available.

It seems clear, from the different institutional approaches, that although no survey on R&D activities has been launched until the present, its future implementation depends on a clear commitment from both INSTAT and the Ministry of Science and Education, to which international organisations can make a strong contribution.

Bosnia and Herzegovina

The collection of statistics is carried out by the two Entities' Statistical Offices, with the consolidation of data being done by the State Agency for Statistics of Bosnia and Herzegovina. There has been some cooperation between the Federal Office and Srpska Statistical Office, but not in the area of S&T.

Srpska Republic

The Sprska Republic Institute of Statistics has not launched a survey on research and development statistics so far. While it does not collect such data, it collects education data, including higher education, following ISCED classification, which can eventually be an important resource for the future development of analyses focusing on S&T careers.

Federation of Bosnia-Herzegovina

The Federal Office of Statistics has just launched for the first time a survey on research and development activities in the Federation of Bosnia and Herzegovina. This was a pilot exercise but not completely successful, and the data collected were not processed for publication. Without an appropriate Science Law (presently under discussion; the Sarajevo Canton already has a corresponding Law), there was no institutional framework to enforce responses, which resulted in a very low level of data collected.

The guidelines supporting this survey were based on the *Frascati Manual*. All the work of adaptation, including the survey forms, was done internally at the Office. Although it was expressed that help from international experts would have been very valuable, the adaptation of the Frascati Manual did not create major problems, with the exception of the application of the FTE definition , which raised some difficulties. No international cooperation activities have been developed in this area. The survey was launched in three parts: for the business sector, for the State sector, and for higher education (the non-profit sector was not identified). It was also expressed that the area of S&T is not a current priority, both at the national level as well as from the perspective of the international community that has supported the stabilization process in Bosnia and Herzegovina.

Nevertheless, there is a clear wish to repeat the survey in the near future, with the objective of getting better quality data. Data on R&D expenditure will always be more sensitive than the survey on research personnel, and will be also more difficult to collect. This is also partly due to the decentralised nature of the Federation, with significant responsibilities at the level of the Cantons, which makes it more difficult to centrally collect corresponding data.

Bulgaria

In the S&T field, the National Statistical Institute (NSI) has launched surveys on R&D activity, on human resources in S&T and on completed R&D projects. The required internationally comparable data is compiled and provided to Eurostat annually.

The R&D survey is expected to be further improved in the near future, namely through the inclusion of R&D expenditure data by scientific fields and of the Nomenclature for Analysis and Comparison of Scientific Programmes and Budgets (NABS), for Eurostat, as well as the further development of R&D activity according to UNESCO standards.

Greater attention is expected to be given to the role of 'Women in Science', through the participation in the corresponding EU project, and to the distribution of government grants according to socio-economic objectives.

As regards the innovation statistics, work is being undertaken to develop a statistical inquiry needed for conducting a test survey of innovations in Bulgaria, in compliance with the *Oslo Manual* requirements and Eurostat recommendations on the Third Community Innovation Survey.

Statistics on the Information Society, which are particularly important for the recently developed indicators on the knowledge-based economy, have been the object of one component in a twinning project with German and Danish statistical offices. It should also be noted that, in addition to the traditional education statistics, from pre-primary education in kindergarten to doctoral studies, vocational education and training have also been included, and are one of the axis in the National Plan for Economic Development, therefore contributing to give greater visibility to the model of a *Learning Society*.

Croatia[11]

As previously mentioned, the main institution responsible for developing methodology and technical notes, collection, processing, publishing and revision of the data related to R&D is the Central Bureau of Statistics of Croatia (CBS): Department for Education, Research and Development, Culture and Social Welfare. The scientific and research activity is defined by the Act on Scientific Activity and Higher Education, and levels of education according to the National Standard Classification of Education (NSCE). The collection of R&D statistics at CBS follow essentially EUROSTAT guidelines, and statistics on levels of education are collected according to the National Standard Classification of Education (NSCE).

Since 1970 CBS provides data on Higher Education (HE). The database on HE includes all types of university students based on NSCE classification (harmonized with ISCED -97), institutions and staff. CBS in Croatia has not established yet the database on the Financing of Education and the corresponding data are based on report by the funding Ministry (e.g. Fiscal database established by IMF GFS Methodology).

Data on R&D has been collected since 1972, and the Frascati Manual has been used for the official data collection since 1996. The CBS provides comparative data available from the period 1997 to 2002. Data is collected in three independent surveys. For the business sector,

[11] The following has greatly benefited from a presentation made available for this study by Ms. Emira Becic (2003) of the Ministry of Science, Education and Sports, in addition to local interviews.

data coverage is limited to companies (including public enterprises) with more than 100 employees, officially registered by the Act on Scientific Activity and Higher Education (according to the National Classification of Economic Activities). Therefore coverage is limited, and not all business organizations performing R&D are included in the official statistics. Some variations are also likely to exist on the response rate of firms, resulting in significant oscillations in BERD figures.

The survey on the government sector includes public institutes and R&D departments of health care institutions. For the higher education sector the survey includes faculties/universities and all other institutions of higher education.

The R&D survey includes the data on the Human Resources in R&D: number of researchers; R&D personnel (FTE); R&D expenditure; number of scientific publications and number of publications; number of patents.

The CBS has not launched so far an innovation survey to collect data on innovation activities by firms, but it intends to start doing so in 2007-08. In fact, the recently approved CARDS programme for Croatia in the statistical area includes the launching of an innovation survey as one of its main priorities.

A Pilot Innovation Survey was recently initiated by the Institute of Economics in Zagreb. Launched independently, the response was not compulsory and it did not achieve a very high response rate. Even if this survey did not fully implement the Oslo Manual guidelines, the coordinators for launching the survey believe that the results are comparable with CIS III data and expect to launch a new survey to follow CIS IV surveys in progress. For this occasion, the direct collaboration with CBS is being sought, through the Unit on Education and Science, which will be responsible for initiating work on an innovation survey under the new CARDS programme.

Although the collection of statistics is relatively advanced and with a wide coverage, the quality of the data still requires further improvements, and some new areas of indicators are not being covered yet (which is not surprising taking into account the human resources involved, with only one statistician working on this area, in addition to work in other fields). Such is the case, for example, of data on 'Public Understanding of Science', on 'University-Industry Collaborations' (although some individual surveys have taken this on), or on the trajectories of PhDs (data on new PhDs is however collected). In addition, the following data was identified as partly missing, not being collected systematically or not being complete enough: structure of research employment, GBAORD (projected for 2006), regional R&D data, patents (see below), public and private funding, life long learning, innovation capacity, technological balance of payments.

From a policy-making perspective, three areas were identified where dedicated indicators, not available at present, would be of particular usefulness for policy-making. These were data on training and mobility, indicators on research project funding and allocation decisions, and indicators on the quality of young scientists to guarantee the support to the most promising scientists.

Output data, on publications of Croatian scientists, is collected and analysed through three main sources (Silobrcic, 2005). Data is collected through the R&D survey, distinguishing between sectors, scientific fields, type of research, and location of publication, at home or abroad, but not between types of publications. Data on publications in Croatia is also collected independently by the National and University Library in Zagreb, aggregated through the register of PhDs in the Ministry of Science, Education and Sports. In addition, some more in-depth studies have been made using data from international citation databases. The typical problems with these different sources also apply here.

The data on Patents are collected in the frame of the R&D survey, in addition to the information that is continually updated by the Croatian Patent Office.

More generally, the need to engage policy-makers in this process was particularly stressed by several interviewees. This clearly reflects not only the current policy discourse that focuses on the knowledge economy, but also the importance being ascribed to 'Science and Research' as the first chapter to be negotiated in accession to EU talks. It was emphasised that the development of indicators is an important activity to contribute to the understanding of future growth paths of the local industry.

FYR of Macedonia

The collection of data on S&T activities, at the State Statistical Office, follows the main international standards. Wide changes were introduced in this system in 1998, when the international methodology, based on the OECD Frascati Manual, was adopted.

Therefore, time series have a break in this year and historical comparisons of the evolution of the system are difficult to make. The main changes introduced then were related to the definitions of activities applied and to the introduction of 'Full Time Equivalent' counts of human resources dedicated to S&T.

The staff responsible for Science statistics noted that they have not been receiving the survey from UNESCO recently (which may mean that UNESCO's survey is being responded by the Ministry of Education and Science).

Data is collected through an annual survey. In the public sector, the survey is applied to the population of identified reporting units. This follows from the Register of Scientific Institutions by the Ministry of Education and Science, according to the Law for Scientific Research Activity (13/96 – art. 21), and includes also additional organisations in the business sector and other research organisations.

Nevertheless, one of the main problems identified (noted both by the State Statistical Office and by the Ministry of Education and Science) is that there have been non-responses from some institutions, even if the survey is compulsory. Non-response is identified in the last report as 12,5% of the reporting units, but concerns were also expressed that some particularly active organisations have not responded. The Ministry of Education and Science has been most concerned with this and has been pressing with the different institutions to obtain the responses to the questionnaires.

The presentation of data from the R&D survey has its main emphasis on human resources, and their distribution according to the different variables surveyed. There are some issues concerning over the data on human resources in S&T which should be clarified. The resulting figures presented appear to include a wider set of human resources count than strictly those involved in R&D. This is the case with data collected in 2003 on the total personnel involved in "R&D and pedagogical work" (identified as R&D only in other sections) in the business sector, which appears to be too high taking into account wider international experiences and the local economic development. Moreover, it does not correspond to data presented elsewhere in the same report. Although this is likely to be simply a typographic issue, the robustness of other HRST data, in total headcounts, is also not fully clear.

Furthermore, the application of FTE counts is not fully explicit. FTE data is presented as separate from full-time workers, while it should in fact correspond to the sum of both (data which is presented, but identified as "Persons in paid employment in R&D with full time and FTE"). The application of FTE counts in the questionnaire possibly requires further explanation to be given to the survey respondents. This was recognised as having been a major difficulty faced by respondents to the questionnaire.

All HRST data is disaggregated by gender, by sector of performance (no data is reported for the Private Non-Profit sector), by type of employment (research or other identified activities). Data is also presented according to educational attainment (PhD, MSc, Specialisation, University degree, Non-university degree, Secondary degree, and other), age, ethnic affiliation, scientific field and type of research (basic, applied or experimental development). No disaggregation is provided on the basis of regional distribution.

The Ministry of Science is building a registry of researchers, including different data on the activities of the researchers, although the response rate so far has not been very encouraging. Although the Ministry promotes a more stringent review process of the proposed projects, with reference to international publications, staff has not yet been trained in analysing bibliometric data.

Financial data from the R&D survey is organised according to three main variables: data on expenditure; income, according to financial sources; income from research projects. However, the data from these different sources does not appear to coincide, possibly because it reports different accounting units or due to incomplete responses. Distinction between R&D and other activities should be made clearer.

A pilot innovation survey was launched in 2001. Although it was in fact developed as a study on the establishment of the Technology Watch Centre in Skopje, it basically surveyed innovation activities by firms, and their sources of information. As such, the methodology did not fully follow the Oslo Manual guidelines, and the results were not considered satisfactory for the SSOM. Although the study did not emphasise the introduction of innovations, the results obtained indicated a relatively high level of innovativeness, with some 50% of respondents declaring that their firm had introduced a product or process innovation, significantly higher than what might be expected from other data.

A new innovation survey has been recently launched, with the data still being processed. The innovation survey was launched under the responsibility of the Sector of Social Statistics, rather than Business Statistics, being clearly framed in relation to R&D.

Other indicators which are being increasingly used in Europe (cf. Annex), such as those related to the technological structure of industry and external trade, to the technological balance of payments, or to GBAORD data, are not being used yet. No output data is reported either by the statistical office, although the Patents and Trademarks Office does collect the respective data.

Although the interest in further cooperation in this area of work was demonstrated, the limitations in terms of the number of staff available for this sector are clear, with particular priority being given to complying with EU standards under the *Acquis Communautaire*. As noted by the Director of the SSOM, the development of new activities in this area will therefore need to be well reflected upon internally, not to over stretch staff, already fully committed to ongoing projects. It was noted that S&T is not yet a priority at governmental level – the main users and as such an important determinant in allocation processes – which limited the resources available for this area in favour of areas such economic, agriculture, employment, poverty, education and health statistics.

Montenegro

Data collection and processing on R&D statistics follows mostly UNESCO standards. Detailed methodologies based on the Frascati Manual have not been introduced. The survey is annual and it is census-based.

As S&T statistics and indicators reveal, the number of active research organisations is very limited (22 in 2004, with almost 600 researchers, mostly in the Higher Education sector, for a total of 1200 employees), which necessarily leads to a lower priority being ascribed to this area.

In the absence of the introduction of Frascati methodology, the data available is limited. Human Resources data collects only headcount figures and does not calculate FTE. No data is currently collected on the sources of funding or on GBAORD. The survey also collects data on research works (publications) finalized during the survey year.

Basic data published includes:

- the number of organizations and units practicing science research and research development activities, by type;
- the staff, by position;
- the results of research (research works), by type of research and sector;
- financial income from research activities.

The definitions used to classify the different sectors do not fully conform with the standard sector definitions, and are the following:

- "Scientific-research institutes represent the group of enterprises, units of enterprises and institutions engaged in scientific-research or experimental-development activities", and

"Experimental-development units represent the group of local units of enterprises or institutions performing the same or different activity". Scientific-research institutes and experimental development units meeting requirements regulated by the Republic's Law on Scientific Research Activity are part of the Register of the competent bodies in charge of science and represent, in statistical surveys, the group of "registered" research organizations. Other scientific-research organizations, not meeting legal conditions, represent the group of "unregistered" scientific-research organizations. By the definition and international recommendations, "Faculties (and Academies of arts)" are educational and scientific-research institutions.

Statistics on R&D are published by the Statistical Office of the Republic of Montenegro, also in English. A summary is published in its Statistical Yearbook.

Romania

The National Institute of Statistics of Romania (NIS) has been collecting statistics on R&D activities on an annual base. The methodology fully follows the Frascati Manual. Data is separated according to sector of performance, type of research, scientific fields, occupation of personnel and their education, type and source of expenditure. NIS has also launched the CIS III Innovation Survey, which is carried out on a sample of enterprises in industry and services, selected by enterprise size (according to the number of employees).

Detailed methodological explanations are presented together with the results of both surveys in a very clear fashion. Results from both surveys are presented in parallel, making clear the strong relation between research and innovation activity in firms.

Although cooperation with the EU, initially under the Phare Programme, started in 1999, only with the latest Phare Multi-Beneficiary Programme has a project on Research and Development Statistics been included for support.

International comparative data for Romania are collected via OECD's Main Science and Technology Indicators (MSTI 2005-1) database.

Serbia

The statistical system in Serbia has had crucial transformations in recent years, as clearly stated in the Statistical Office's strategic document (2006-08). These stem firstly from the wider political changes the country has undergone. Changes in the economic system towards a market economy have also forced changes in the organisation of statistics. Finally, the adoption of stronger international standards, partly as a result of the process of joining the EU as well as to obtain greater international data comparability and trustworthiness following a long period of exclusion from the international community, has also contributed to further changes.

In the field of statistics of scientific research activity, there are three main surveys: the Annual Report of Scientific Research and Research Developing Organizations (NIRO); Scientific Research and Research Developing Institutions – Address Book and Guidebook; and an Aggre-

gated Analytical Survey on indicators of scientific technological activity (corresponding to a future publication, on the basis of existing documentation). It should be noted that the surveys launched do not cover scientific-research and experimental development units established by the Ministry of Internal Affairs or by the Ministry of Defence.

Data collection and processing on R&D statistics has developed partly on an experimental basis. There has been little external help on this area. The methodology follows UNESCO standards, and in recent years Frascati methodology has been slowly introduced, although not fully implemented yet.

The decision to implement Frascati methodology was made on an *ad hoc* basis. It was expressed that some limitations were found in the interpretation of the definitions of the Frascati Manual due to language issues. English language courses had been offered, in recent years, to the staff of the statistical office, but some clarifications were often necessary regarding original documents in English, highlighting a potential area for future cooperation.

It was generally considered that there was little attention being given by users, namely at governmental level, to S&T statistics, and that this also reflected the low priority of S&T policy in the country, in face of other social and economic issues.

The development of S&T statistics at the Statistical Office of the Republic of Serbia has been essentially based on the annual R&D survey, following the Frascati Manual. It covers the four sectors of government, business, higher education and private non-profit, and it is census-based.

However, some potential limitations of coverage were identified. Coverage of the business sector is likely not to be complete. Business firms identified were those with R&D units registered through the Ministry of Science, and no other efforts are made to assess such coverage. In fact, external users have considered that the focus on research, through the Ministry lens, may leave out of the coverage engineering firms with relevant development work.

The Human Resources data is collected only in headcount figures, and does not calculate FTE. It is based on information from the Reporting Units and is not an individual survey to all researchers. These data are also affected by the legal framework, as the Law of Science defines who is a researcher, and this is the basis for the attribution of public funding, imposing constraints on such identification. This might have an impact on an under-estimation of the number of researchers in the country.

Although the SORS does not collect FTE data (an issue also linked to the legal framework), there exist estimations of FTEs of research personnel – and published figures by the Federal Statistical Office, but the figures are contested in some circles.

Human Resources data is otherwise collected according to the main variables: gender, education level, sector of performance, scientific fields. No data is collected on the sources of funding

or, separately, on GBAORD. The survey also collects output data on publications, research projects and patents, although these outputs may vary.

With the existing limitations on fully implementing the Frascati methodology, the Statistical Office does not have the capabilities to follow on the development of new indicators. The Statistical Office has not launched so far an innovation survey, and it was clear also that R&D statistics were still very much produced in the frame of the links between science and education, rather than of the links between science and innovation. No data is produced on the technological structure of industry (classification of industries according to technological intensity) or on the knowledge intensity of business services (KIBS). No data on the Technological Balance of Payments is collected by the statistical office.

The survey provides the data on the scientific capacities:
- the number of organizations and units practicing science research and research-development activities, by kind, science branch and economic section;
- the staff, by educational attainment, occupation i.e. position, the type of employment, office hours, age and fluctuation;
- financial resources (receipts, expenditure and investments), by the kind of research, funding sources and destination;
- the results of research activities: research works (completed, in the process of execution and published works), by kind of research, purchaser and science branch;
- the inventions and patents, by science branch and the development dynamics.

The definitions used to classify the different sectors do not fully conform with the standard sector definitions, and are the following:
- research institutes, i.e. independent research institutions, enterprises and offices that feature science research or research-development as the principal or prevailing activity;
- research-development units within enterprise or institution;
- university institutions (faculties and academies of arts) with officially recognized activities of education and research.

Statistics on R&D are published by the Statistical Office of the Republic of Serbia, in Serbian language. Summary figures are included in the Statistical Yearbook (bilingual), but are not included in the Statistical Pocket Book.

Regarding output data, the Ministry of Science uses data on scientific articles through the *Current Contents* of the Institute for Scientific Information (ISI) for evaluation purposes, but no official data is published. Similarly, no analysis of patent data, available at the patent office, has been developed.

Independent exercises on innovation have nevertheless been launched. A pilot survey on innovation was developed through the European Agency for Reconstruction and Development, at the Ministry of the Economy, focusing only on SMEs, and using the earlier version of the Oslo Manual. A Research Institute is developing an Innovation Survey for the ICT sector. A new innovation survey, for large firms, was in the process of being launched through UNDP.

4.3. Development of Capabilities in S&T Statistics and Indicators

The analysis presented in the sections above offers a general overview of the status of S&T statistics and indicators production and use in the SEE countries. Although, due to the pilot nature of this study, this overview cannot aim to be fully extensive, the description presented above allows to make some clear conclusions on the state of affairs in this area.

These countries have quite distinct contexts in relation to S&T data production. While some have already stabilised the main R&D survey, following the Frascati methodology, this survey has not been fully launched in all countries. Albania, Montenegro and Serbia have not yet fully implemented this methodology. The lack of implementation of internationally harmonised indicators is greater for indicators on the innovation processes.

However, and even if these research systems have more that distinguishes them than what unites (Radosevic and Kobal, 2005), the common points between the status of S&T indicators in these countries are more significant than their differences. Let us enumerate some of these:

- *statistical offices are clearly understaffed in this particular area*, with typically 1 statistical officer, who follows S&T statistics together with higher education statistics; in these context, it is often quite impressive the work that has been developed and achieved;

- *the application of the Frascati methodology has been progressive and, mostly, not fully implemented so far;* for example, GBAORD data has typically not been collected;

- in some cases there has been *limitations in the coverage obtained*, or in the application of the concepts of the survey; human resources data is particularly sensitive, namely regarding the application of the FTE approach;

- *no full fledged innovation survey has been launched so far,* although it is a top priority for future development in several countries;

- S&T statistics are commonly part of the sector on social statistics, and are understood as being essentially close to education; linkages with business statistics are not common;

- data collection reflects wider policy priorities by its main users: in particular, *S&T is given low priority at the national level*, in face of other more short-term needs such as economic and social stability, and it reflects essentially a 'science policy' approach rather than an 'innovation policy' approach, generally reflecting the corresponding policy strategies being implemented in these countries;

- in this way, *there is still reduced awareness of emerging indicators*, that go beyond the view of the research system to a more open view of the innovation system;

- the statistical offices have benefited from different international cooperation initiatives, often in the framework of the Stabilisation and Association process with the European Union, in some cases through joint Multi-Beneficiary Programmes; however, science and research only recently started to be addressed in such activities;

- in general, the statistical offices have policies for the public dissemination of results, through the institutional webpages, with information often available also in English;

- *linkages with different users in government, academia or in business are relatively weak*, although this is clearly not the situation across all countries;

- *there are relatively few local researchers studying S&T policy* in these countries that can act as more demanding and critical users, participating in the collective development of new indicators with the main relevant producers.

This analysis, albeit from a different entry point, reflects what Uvalic (2005: 55) has suggested as a common priority in all the SEE countries she studied, i.e. the need "to raise public awareness about the importance of the knowledge-based economy, recognising the key role of innovation and technological progress, and the strong link between S&T and economic development." This is of particular importance as indicators are precisely an element of visibility of the system. Even if not necessarily making evident a strong impact on economic development, indicators can make particularly visible the extent to which there is a match between political discourses that portray images of 'knowledge societies' and the existing conditions. The analysis above of the state of the art of S&T statistics and indicators in SEE countries makes clear the need to provide further support to the development of capabilities in this area. This is likely to follow two main paths.

Firstly, **the internal capabilities for the production of STI statistics must be improved**. Although it is clear that the existing resources do not allow significant changes, greater political interest in this area, inevitable in face of the need to move towards knowledge-based economies, as well as the future accession to the EU, is a precondition for such changes to happen.

In a recent study, Esterle and Thèves (2005) have identified different national models for the organisation of the production of S&T statistics and indicators. Characterising the main producers of data and indicators, they found that, typically, the Frascati type input data is entrusted to the national statistical offices. In two countries they studied, dedicated offices attached to the Ministries of Science had delegated responsibilities, and in another case a public research institute also had official statistical responsibilities. In relation to non-Frascati type input data there was a much more diverse set of data producers, from statistical offices to ministries or specialised research institutes. In relation to output data, the patent offices had a central role (namely in relation to patent data), but there was less consistency in relation to publication data. Besides the production of data, they also discussed the analytical capabilities of the relevant actors, namely through the dissemination of S&T indicators reports which go beyond the publication of survey results. They concluded in this matter that there is little internal capability within the statistical offices, but that the offices relied to a significant extent

on the involvement with research organisations in this area. As a result, priority is being given to the collection of OECD type data and there has been weak investment on strategic indicators (Esterle and Thèves, 2005).

Two different models were identified. In Portugal 35-40 technical officers work in the Observatory of Science and Higher Education (OCES), the national office responsible for the production of statistics in this area. The Observatory is a Directorate-General of the Ministry of Science, Technology and Higher Education, with delegated responsibilities from the National Statistical Office for the collection and production of statistics in science and technology (Frascati type). Since recently, it also produced work on other indicators, namely in the area of higher education. Beyond R&D statistics, OCES is also responsible for launching the Community Innovation Survey, therefore encompassing industrial activities related to science and technology.

In France, responsibility for the collection of official statistics on R&D (Frascati type) is delegated to the *Bureau des Études Statistiques sur la Recherche*. This office is part of the statistical service of the Ministry for Youth, National Education and Research, within the Official Statistical System, coordinated by the National Institute for Statistics and Economic Studies (INSEE) and the National Council for Statistical Information (CNIS). Essentially dedicated to Frascati data, this office employs 11 technical staff in its team.

Contrary to the Portuguese case, in France the statistical responsibilities in this area are not all aggregated in one single institution (in fact the French system entails multiple responsibilities). Statistics more directly related to the industrial activity are produced by the Industrial Studies and Statistics Department (SESSI) of the Ministry in charge of Industry. These include in relation to science and technology, for example, the launching of innovation surveys and the consolidation of data on international technology transfers. In addition, the production of indicators on S&T in France has also a specially dedicated institute for S&T indicators, the *Observatoire des Sciences et des Techniques* (OST). OST focuses on the analysis of output data and on the production of an analytical report of S&T indicators in France.

Although these models may not be necessarily the more appropriate for these countries, namely due to the different size of the research systems, they can help to consider a model in which S&T is not addressed simply as an activity performed at higher education establishments, to which it becomes 'statistically correlated' to.

Secondly, **the future development of existing statistics and indicators, or the development of new ones, will depend very strongly on the role of the users**. This statistical work is a perfect example where "user-producer interactions" (Lundvall, 1992) is a central process for the introduction of innovations. Users should be viewed here with a wide scope, including policy-makers, but not only in science policy, as well as business firms and academic researchers who have specific indicator needs and who can also contribute to assess the quality of the data. There are an array of indicators that are simply not being produced at the moment or are produced only partially and where the interest of the users can have a fundamental effect in future decisions.

The development of training activities, joining these different users of the system, and the continuation of international cooperation processes in statistical work should be further developed. In this context, direct dissemination activities of the existing indicators and their methodologies for the users of the data as well as for data providers should be further explored. As an example, the following table presents data on the dissemination of OECD methodological knowledge in CEECs, reflecting the lack of dissemination.

Table 1 - Dissemination of OECD methodological knowledge in CEECs - Year of publication in the national language

Countries	Frascati Manual	Oslo	TBP	Patent	Canberra
Bulgaria					
Czech Rep.	Auth. '94				
Estonia	Auth. '99 (S)				
Hungary	1996 (T)	1996 (T)	1995 (S)	1998 (S)	1999 (T)
Latvia					
Lithuania					
Poland	Auth. '95	Auth. '99			
Romania					
Russia	1995 (T)	1998			
Slovenia	Yes				
Slovakia	Yes				
Ukraine					

Notes: T – translation; S – summary; Auth. – authorized

Source: Inzelt, Annamária (2003) *"Targets and instruments for capacity-building in the accession countries"*, in *Building European Research Capacity, Proceedings from Muscipoli Workshop Three,* Danish Institute for Studies in Research and Research Policy, Aarhus.

Further work in this area, as proposed in a separate Project Proposal, should focus precisely on bridging producers and users of data, short and medium-term needs, and local/regional actors of the statistical systems with international ones.

5. Conclusions and Recommendations

This Pilot Study of the status of production and use of S&T statistics and indicators in SEE countries has provided an overview of the local activities in this area. Although there are some relevant differences among the countries analysed, there are common general trends that lead to the following conclusions.

Science and technology are still a low priority in the national statistical systems. This reflects generally the overall lack of human and financial resources in the statistical offices, often stretching its resources among additional activities required in preparation for accession to the EU. But this low priority reflects primarily the low priority generally ascribed to S&T policy more generally. Although in the present period S&T, and knowledge more generally, are key resources for future growth, policy-makers have not been able so far to implement and forcefully disseminate the view that future progress depends on present change and support of knowledge producing activities.

With other short term priorities, statistical offices have not been able to fully address different requirements. In one country, Albania, the R&D survey has not been launched at all, so far. Others have partial limitations in the treatment of data according to the standard Frascati Manual. **One area where the producers of statistics recognize that there has been more difficulty in implementing the standard has been that of Human Resources**, which requires the application of FTE. This ought to be a primary area to address, also because human resources is a most pressing concern in the region. Other data not included so far, and which ought to be developed, is the collection of data on Governmental Budget Appropriations On Research and Development (GBAORD).

The improvement of the quality of existing data is essential to guarantee appropriate comparative data and to effectively develop international comparisons. Nevertheless, there are further indicators, beyond those encompassed in the Frascati Manual, that have been little explored. Primarily among these is the *Innovation Survey*. This is a central element for an understanding of the wider impacts of the research process and to support the development of a full-fledged innovation policy. While in Romania and Bulgaria this has already been implemented, other countries have either launched experimental pilots, or not addressed the topic at all. In addition, *general indicators*, such as on the Technological Balance of Payments and on the Technological (or Knowledge)Intensity of International Trade in industry and services can easily complement this view. There are naturally other indicators that have been only weakly explored, or even not explored at all, but clearly quality should not be substituted by quantity.

More importantly, the development of the quality of this data and of new indicators depends to a large extent on the **close interaction between its users and producers**. Policy-makers in particular can have a central role in highlighting the importance of work in this area, in identifying

data weaknesses and in contributing to the strategy of development of new indicators. The development of a training seminar, addressed to policy-makers, academic users and statistical officers should be sought, not only because of the learning process it provides, but also to better understand the other's point of view in relation to S&T data.

Naturally, **international cooperation processes are of particular importance** here. These countries have benefited from various support programmes, partly in the context of the Stabilisation and Accession process, partly in twinning programmes, or through more detailed expert visits. However, the area of S&T statistics has generally not benefited, or is just starting to benefit, from such cooperation. Extension of those programmes to this area should be sought. In addition, taking into account some similar conditions, both in the research system as well as in the S&T statistics production, **further regional cooperation** appears to be a promising step to overcoming some current data limitations.

In the move towards knowledge based economies, science and technology, and knowledge production activities more generally, are at the centre of these changes. The improvement of the statistics available will be not only a contribution to policy-making in this area, and better informed decisions, but will also contribute to raising the public awareness about the importance of science and technology for the future growth models of these countries, the main priority stressed by Milica Uvalic (2005), in a recent study for UNESCO of S&T and economic development in these countries.

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ANNEX I

Details of Missions and Contacts

Albania

Tirana, 17 November 2005

MEETING 1

Ms. Milva Ekonomi
Director General
INSTAT
Albanian Institute of Statistics

Prof. Dr. Dhimiter Tole
Director of IT
INSTAT
Albanian Institute of Statistics

MEETING 2

Mr. Edmond Agolli
Directorate of Scientific Research
Ministry of Education and Science

MEETING 3

Dr. Fatos Dega
Albanian Centre for Science, Technology and Innovation Policy

Bosnia and Herzegovina

Sarajevo, 15-16 November 2005

MEETING 1

Ms. Amra Avdagic
Assistant Minister for Science
Federal Ministry of Education and Science
Federation of Bosnia and Herzegovina
Bosnia and Herzegovina

Ms. Danica Radic
Secretariat
Academy of Sciences and Arts of Bosnia and Herzegovina

Ms. Dina Masnik
Translator/Independent Consultant

MEETING 2

Mr. Hajrudin Alic
Head, Department for Education, Research, Technology, Social Welfare and Administration of Justice
Federal Office of Statistics
Bosnia and Herzegovina

Croatia

Zagreb, 17-18 October 2005

MEETING 1

Ms. Emira Becic
Senior Advisor
Minister of Science, Education and Sports

Mr. Zoran Aralica
Researcher
Institute of Economics Zagreb

Mr. Veljko Pavlakovic
Senior Advisor
Central Bureau of Statistics

Mr. Domagoj Racic
Researcher
Institute of Economics Zagreb

Ms. Jadranka Svarc
Researcher
Institute of Social Sciences 'Ivo Pilar'

MEETING 2
Dr. Mladen Petrovecki
Deputy Minister
Ministry of Science, Education and Sports

MEETING 3
Mr. Darko Jukic
Acting Director General
Central Bureau of Statistics

Mr Robert Knezevic
Head of Director General's Office
Central Bureau of Statistics

Former Yugoslav Republic of Macedonia

Skopje, 9-10 February 2006

Meeting 1
Mr. Apostol Simovski
Director
State Statistical Office

Ms. Marina Miovska
Head of Sector for Social Statistics
State Statistical Office

Ms. Marica Aleksik
Department for Social Statistics, Education and Science
State Statistical Office

Ms. Vesna Cvetanova
Acting Head
European Integration & International Cooperation
State Statistical Office

MEETING 2
Dr. Viktor Stefov
Head of Scientific Council
Ministry of Education and Science

Meeting 3
Mrs. Stanka Petkovska
Adviser
Ministry of Education and Science

Meeting 4
Ms. Irena Jakimovska
Head of Patent and Technology Watch Department
State Office of Industrial Property

Serbia

Belgrade, 19-20 October 2005

Meeting 1
Ms. Branka Surkalovic
Head, Department for Statistics of Education and other Social Activities
Statistical Office of the Republic of Serbia

Ms. Suncica Stefanovic-Sestic
Group Manager, Division for Statistics of Education and Science
Statistical Office of the Republic of Serbia

Meeting 2
Dr. Ivan Videnovic
Assistant Minister
Ministry of Science and Environmental Protection

Meeting 3
Dr. Djuro Kutlaca
"Mihajlo Pupin" Institute
Science and Technology Policy Research Centre
Official Representative to NESTI Meetings

ANNEX II

Main Institutional Links

The following list presents institutional contact details from the different Ministries of Science and from the National Statistical Offices in South-East Europe

Albania

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INSTAT – Albanian Institute of Statistics

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Bosnia and Herzegovina

Agency for Statistics for Bosnia and Herzegovina

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Federation of Bosnia and Herzegovina

Federal Ministry of Education and Science

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Federal Office of Statistics

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Srpska Republic

Ministry of Science and Technology

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Republika Srpska, BiH
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Montenegro

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ANNEX III

Methodological Manuals and Relevant Documents

A list of some central documents and manuals, from International Organizations, on S&T Indicators and Statistics.

UNESCO

- *Recommendation concerning the International Standardization of Statistics on Science and Technology*, Paris, 1978.
- *Manual for Statistics on Scientific and Technological Activities,* (ST-84/WS/12), UNESCO, Paris, 1984.
- *Immediate, Medium and Longer-term Strategy in Science and Technology Statistics*, UNESCO Institute for Statistics, Montreal, 2003.
- UNESCO Institute for Statistics web site: www.uis.unesco.org.

OECD/Eurostat

Research and development - The "Frascati family"

- *The Measurement of Scientific and Technological Activities Series. Frascati Manual: Proposed Standard Practice for Surveys on Research and Experimental Development*, OECD, 2002 (first edition, 1963).
- *R&D Statistics and Output Measurement in the Higher Education Sector*, 'Frascati Manual Supplement', OECD, 1989.

Technology balance of payments

- *Manual for the Measurement and Interpretation of Technology Balance of Payments Data – TBP Manual*, OECD, 1990.

Innovation

- *Guidelines for Collecting and Interpreting Innovation Data – Oslo Manual*, 3rd edition, OECD, 2005 (first edition, 1992).

Patents

- *Using Patent Data as Science and Technology Indicators* – Patent Manual 1994, OECD, OECD/GD(94)114, 1994.

Science and technology personnel

• *The Measurement of Human Resources Devoted to Science and Technology – Canberra Manual*, OECD, 1995.

OTHER METHODOLOGICAL FRAMEWORKS FOR S&T INDICATORS

High-tech

• *Revision of High-Technology Sector and Product Classification*, STI WP 97/2, OECD, 1997.

Bibliometrics

• Y. Okubo, *Bibliometric Indicators and Analysis of Research Systems*, *Methods and Examples*, STI WP 97/1, OECD, 1997.

Globalization

• *Manual of Economic Globalisation Indicators* (provisional title, forthcoming).

ANNEX IV

Previous Relevant Meetings

Follows a list of some previous relevant meetings regarding S&T policy and indicators in South East Europe.

Round Table of Ministers of Science: Rebuilding Scientific Cooperation in South East Europe
24 October 2001, UNESCO Headquarters, Paris, France

CIPRE Mentor Seminar for STI Policy-makers and Administrators
7-11 November 2001, Budapest, Hungary

International Expert Meeting
2-5 April 2002, UNESCO Institute of Statistics, Montreal, Canada

Towards a new UNESCO short and medium term strategy in Science & Technology Statistics
24-26 March 2003, Paris, France

UNESCO Workshop "S&T Indicators and Statistics for Science Policy Making in SEE"
16-18 November 2003, Centre for Science Studies and History of Science, Bulgarian Academy of Sciences, Sofia, Bulgaria

ANNEX V

S&T Statistics and Indicators Used in International Exercises

This Annex presents statistics and indicators collected for the UNESCO Institute of Statistics database, the most representative worldwide collection of statistics in the S&T field, as well as recent developments of a wider collection of indicators in S&T and Innovation in the EU.

Statistics collected for the UNESCO Institute of Statistics S&T Database

Human resources (number of personnel engaged in R&D)
- by category of personnel (researchers, technicians and equivalent staff and other supporting staff);
- by sector of performance;
- by field of science and technology; and
- by branch of economic activity.

Financial resources (gross domestic expenditure on R&D)
- by type of expenditure;
- by sector of performance;
- by field of science and technology;
- by source of funds;
- by branch of economic activity;
- by major socio-economic objective; and
- Current intramural expenditure by type of R&D activity.

Government budget appropriations or outlays for R&D
- by major socio-economic objective; and
- by sector of destination.

Indicators produced for the UNESCO Institute of Statistics S&T Database

Human resources:

- Total R&D personnel (Full time equivalent – FTE);
- Researchers, by gender (FTE);
- Researchers (FTE) per million inhabitants;
- Technicians, by gender (FTE);
- Technicians (FTE) per million inhabitants ;
- Other supporting staff (FTE); and
- Number of Technicians by researcher.

Financial resources:

- Total Gross Domestic Expenditure on R&D (national currency);
- Gross Domestic Expenditure on R&D by source of funds (percentage);
- Total Gross Domestic Expenditure on R&D as a percentage of GNP;
- Total Gross Domestic Expenditure on R&D per capita (national currency);
- Average Gross Domestic Expenditure on R&D per researcher (national currency).

Indicators used in the European Commission 'Indicators for Benchmarking of National Research Policies', Key Figures 2001

The following list includes the comments on the status of development of the different indicators, as mentioned in the report. Further exercises have followed, but the 2001 exercise was included for its comprehensiveness and analysis of the status of development.

Theme 1 – Human Resources in RTD, including attractiveness of science and technology professions

INDICATORS	STATUS	FURTHER DEVELOPMENTS TO BE EXPLORED	SCIENTIFIC AND SOCIOECONOMIC MEANING
• Number of researchers in relation to the total workforce	Data available; *Source:* Eurostat/OECD/ Member States	• Investigate how comparability of data could be improved; Breakdown by industry, universities and public research centres	Measures the human resource capacity in R&D of each country and its breakdown by main sector
• Number of new science and technology PhDs in relation to the population in the corresponding age group	Data available; *Source:* Eurostat/OECD/ UNESCO	• Breakdown by discipline, including socioeconomic sciences; Breakdown by the country of origin	Indicates the increase in the highlyqualified human knowledge base
• Number of young researchers recruited in universities and public research centres in relation to the total number of researchers	New indicator; (to be developed)	• Data on average age of researchers and number of research posts created; share of researchers retiring in the next 10 years; Salary levels	Reflects the attractiveness of science for young people and the prospects for sustaining a knowledge-based economy
• Proportion of women in the total number of researchers in universities and public research centres	New indicator; (to be developed)	• Investigate possibility of breakdown by level of responsibility	Indicates the participation of women in science and their role in contributing to knowledge resources
• Proportion of researchers from other countries amongst researchers in universities and public research centres	New indicator; (to be developed)	• Breakdown by country of origin; Data on researchers' participation in European programmes	Reflects the international attractiveness of national science systems and measures the diffusion of external knowledge

Theme 2 – Public and Private Investment in RTD

INDICATORS	STATUS	FURTHER DEVELOPMENTS TO BE EXPLORED	SCIENTIFIC AND SOCIOECONOMIC MEANING
• Total research and development expenditure in relation to GDP and breakdown by source of funding	Data available; *Source:* Eurostat/OECD/ Member States	• Breakdown of the funding by basic and applied research	Measures the economy's propensity to allocate resources to research and development
• Research and development expenditure financed by industry in relation to industrial output	Data available; *Source:* Eurostat/OECD/ Member States	• Proportion of R&D executed by industry financed by public funding	Measures the relative importance of business sector R&D expenditure in the total economy, and public support for R&D executed by industry
• Share of the annual government budget allocated to research	Data available; *Source:* Eurostat/OECD/ Member States	• Breakdown of research budget by main policy objectives; • Allocation of budget to policy support; • Breakdown of research budget by main sector (e.g. civil and defence)	Measures the relative importance given to R&D in the government's general spending commitments
• Share of SMEs in publicly funded R&D executed by the business sector	Data available (but no regular harmonised statistics)	• Proportion of SMEs (and if possible new SMEs) amongst enterprises conducting research activities	Measures the public support for research activities of SMEs
• Volume of venture capital investment in early stages (seed and startup) in relation to GDP	Data available (but no harmonised statistics); *Source:* EVCA, NVCA, AVCA, Member States	• Investigate how comparability of data could be improved; • Share of venture capital invested in high-tech industries	Indicates the financing of new highgrowth/ innovation-based firms

Theme 3 – Scientific and Technological Productivity

INDICATORS	STATUS	FURTHER DEVELOPMENTS TO BE EXPLORED	SCIENTIFIC AND SOCIOECONOMIC MEANING
• Number of patents at the European and US patent offices per capita	Data available *Source:* EPO/USPTO	• Share of patents in high-tech areas • Explore other possible scaling factors (e.g. business R&D expenditure, number of researchers)	Measures technological performance of countries
• Number of scientific publications and most cited publications per capita	Data available *Source:* Science Citation Index	• Breakdown by science domain (examine the possible inclusion of social sciences and humanities) • Explore other possible scaling factors (e.g. non-business R&D expenditure, number of researchers) • Proportion of joint publications in the national total • Need to examine methodological issues	Measures scientific performance and co-operative patterns
• Number of spin-offs generated by universities and research centres	New indicator (to be developed)	• Indicators of performance of spin-offs • Explore suitable scaling factors (per capita, GDP, etc.)	Measures the development of new economic activities by R&D personnel
• Percentage of innovative firms cooperating with other firms/ universities/public research institutes	Data available *Source:* Eurostat	• Other forms of co-operation between universities and industry	Indicates co-operation patterns which may contribute to strengthening knowledge and innovation transfers
• Rate of usage of broadband electronic networks for research by R&D laboratories.	New indicator (to be developed)	• Need to examine methodological issues	Measures the rate of connectivity and use of electronic research networks – the larger and better connected, the more likely is the increase in quantity and quality of scientific productivity and the speedy diffusion of scientific and technological output

Theme 4 – Impact of RTD on economic competitiveness and employment

INDICATORS	STATUS	FURTHER DEVELOPMENTS TO BE EXPLORED	SCIENTIFIC AND SOCIOECONOMIC MEANING
• Growth rate of labour productivity	Data available; *Source:* Eurostat/ OECD/ Member States	• Growth in total factor productivity • Growth rate of labour productivity in high-tech, medium-tech. and low-tech. companies	Measures overall competitiveness of an economy and captures all economic effects induced by innovations and S&T progress
• Share of high-tech and medium high-tech industries (+ their contribution to growth) in total employment and output	Data available; *Source:* Eurostat/OECD/ Member States	• Breakdown by sectors (including contribution of the ICT sector)	Indicates the contribution of high-tech (and medium-high-tech) sectors to growth and employment
• Share of knowledge intensive services (+ their contribution to growth) in total employment and output	Data available; *Source:* Eurostat/OECD/ Member States	• Breakdown by individual service sectors	Measures the contribution to employment and output of knowledge intensive services
• Technology balance of payments receipts as a proportion of GDP	Data available (but not for all countries and all years)	• Breakdown by type of transaction (e.g. rights of use of patents, etc.) • Breakdown by intra-EU and extra-EU • Investigate how to redefine the indicator for S&T purposes	Measures the importance of a country's receipts from exporting technical knowledge and services (including licenses, know-how, trademarks, technical services, etc.)
• Growth in a country's world market share of exports of high-tech products	Data available; *Source:* Eurostat; (Comext)/UN (Comtrade)	• Breakdown by type of product	Indicates changes in international competitiveness in high-tech products

European Innovation Scoreboard 2005

The following lists indicators included in the Innovation Scoreboard, and therefore with a different focus from the previously mentioned EU Report.

INPUT – Innovation drivers

S&E graduates (‰ of population aged 20-29)
Population with tertiary education (% of population aged 25-64)
Broadband penetration rate (number of broadband lines per 100 population)
Participation in life-long learning (% of population aged 25-64)
Youth education attainment level (% of population aged 20-24 having completed at least upper secondary education)
- - -
Internet access - Level of Internet access of Enterprises
Internet access - Level of Internet access of Households
Job-to-job mobility of employed HRST in %
HRSTC as a percentage employed population aged 24-65, 2000
Employed HRST (Human Resources in Science and Technology) - as a % of total employment

INPUT – Knowledge creation

Public R&D expenditures (% of GDP)
Business R&D expenditures (% of GDP)
Share of medium-high-tech and high-tech R&D (% of manufacturing R&D expenditures)
Share of enterprises receiving public funding for innovation
University R&D expenditures financed by business sector
- - -
High-tech venture capital (% of venture capital investment)
Business R&D expenditures financed by government sector
Foreign Direct Investment intensity - Average value of inward and outward FDI flows divided by GDP, multiplied by 100
Share of companies receiving public funding for innovation
R&D expenditures in high-tech manufacturing (% of total manufacturing R&D expenditures)

INPUT – Innovation & entrepreneurship

SMEs innovating in-house (% of SMEs)
Innovative SMEs co-operating with others (% of SMEs)
Innovation expenditures (% of turnover)
Early-stage venture capital (% of GDP)
ICT expenditures (% of GDP)
SMEs using non-technological change (% of SMEs)
- - -

Share of strategic innovators
Share of innovating companies quoting Government or private non-profit research institutes as important source of innovation
Share of innovating companies quoting Universities or other higher education institutes as important source of innovation
Percent of firms involved in networking activities
Share of medium-high-tech and high-tech R&D (% of business R&D expenditures)

OUTPUT – Application

Employment in high-tech services (% of total workforce)
High-tech exports - Exports of high technology products as a share of total exports
Sales of new-to-market products (% of turnover)
Sales of new-to-firm not new-to-market products (% of turnover)
Employment in medium-high and high-tech manufacturing (% of total workforce)
- - -
Value-added in high-tech manufacturing (% of manufacturing value-added)
Share of high-growth innovators
Labour productivity in high-tech manufacturing relative to total manufacturing
Rate of volatility (sum of birth rate and death rate)
Royalties (payments + receipts) as a % of GDP
Value-added in high-tech industries (% of total value-added)

OUTPUT – Intellectual property

(New) EPO patents per million population
(New) USPTO patents per million population
(New) Triadic patent families per million population
Number of (new) domestic community trademarks per million population
Number of (new) domestic community industrial designs per million population
- - -
(New) EPO high-tech patents per million population
(New) USPTO high-tech patents per million population
(New) National patents per million population
Share of innovative companies protecting through copyright
Share of innovative companies protecting through registration of design patterns
Share of innovative companies protecting through secrecy
Share of innovative companies protecting through trademarks

APPENDIX

Project Proposal

SciStatSEE – STRENGTHENING OF S&T STATISTICS AND INDICATOR PRODUCTION IN SOUTH-EAST EUROPE (SEE)

Introduction and Justification

Across the world economies and societies it is now widespread that knowledge is one of the main resources for social and economic development. In this context, science and technology (S&T), through the production of new knowledge, the training of highly qualified personnel, and its impact in the development of technological innovations, take a central role in the future competitiveness of the world's countries. In this way, national governments and international organisations increasingly develop national strategies for science, technology and innovation, which often become a central priority in national policies.

This has also been the case in the South-East Europe (SEE) countries,[12] following a period of transition and political stabilisation. As recently concluded by Milica Uvalic, in a report on "Science, Technology and Economic Development in South Eastern Europe",[13] one common priority in the SEE countries has been "to raise public awareness about the importance of the knowledge-based economy, recognising the key role of innovation and technological progress, and the strong link between S&T and economic development."

It is clear that for such objective to be attained, policy-makers require the availability of the necessary statistics and indicators on the activities, organisation and results of the research system. This has also been a major concern, for example, at the European level, where the European Commission, following the Lisbon Agenda, has engaged in a series of exercises of benchmarking different dimensions of S&T activities in the EU Member States.[14]

In the SEE countries the main priorities in recent years have been those of political and economic stability and security, central to the political transition process. Science and technology, a policy concern with reduced short-term impacts, has received limited attention in these

[12] This project concerns six countries of South East Europe (SEE): Albania, Bosnia and Herzegovina, Croatia, Former Yugoslav Republic (FYR) of Macedonia, Montenegro and Serbia. The Report that resulted in this Project Proposal looked additionally at the situation in Bulgaria and Romania. With the latter two countries already in an advanced process of pre-accession to the EU, the present proposal does not target these countries directly.

[13] Uvalic, Milica (2005) "Science, Technology and Economic Development in South Eastern Europe", UNESCO Science Policy Series Nº1, UNESCO Office in Venice, Venice.

[14] E.g. EC (2005) "European Innovation Scoreboard 2005: Comparative Analysis of Innovation Performance", European Trend Chart on Innovation, European Commission.

countries. As a result, the priorities of statistical activities have also reflected the wider policy concerns, with particular attention being ascribed, for example, to business statistics, employment, poverty, or justice, rather than to S&T.

However, the political discourse is changing, and S&T policy in these countries has been undergoing noticeable changes. The statistical system should, in parallel, accompany these changes and be prepared to provide the necessary tools for the decision-making processes in S&T policy.

The traditional users of S&T statistics, in the government, business or higher education sectors, have been weakly tuned for its wider importance, beyond the primary concerns on short-term budgetary restrictions. As such, there has been a weak demand on these sectoral statistics and indicators. With increasing priority being given to this sector, policy-makers are becoming more aware of the usefulness, and need, of S&T indicators in support for quality decision-making.

While the human resources devoted to S&T statistics in the statistical offices have often been very limited (generally with not more than one person covering the area), these have been slowly improving the available data and methodologies, following international standards.

Goals and Objectives

It is clear for all stakeholders that the development of statistics and indicators in S&T require further development, and increased visibility, to provide the conditions for better informed public policy-making processes, to highlight the need for, and contribute to, increased private sector investment in innovation, as well as for wider social recognition of the state of affairs in S&T in these countries.

The present project proposal a series of activities which are aimed at improving the quality and coverage of S&T statistics and indicators, and its use in policy-making. The activities proposed here have the following main underlying concerns:

- the development of indicators should be closely linked to its use in policy-making;
- improvement of the quality and robustness of statistical work should follow international developments;
- although there is diversity between research systems, there are also some similar concerns, limitations and needs among countries in the region;
- the improvement of statistics and indicators depends on all actors: users, producers, and data providers.

Following this rationale, the project is organised through different Tasks, targeting specific objectives, from short to the medium-term impacts. These include:

- improving the links between users and producers of S&T statistics and indicators, at the system level, regarding the production of data, the acquaintance with the main concepts, and the visibility of the system of data production and its results;
- training of advanced human resources in the production of S&T statistics and indicators;

- developing informal networks of experts, at the regional and international level;
- strengthening the long term development of data at the local level.

The project identifies 6 different Tasks that contribute to achieve these objectives. Although each task may be developed in a relatively independent form, which facilitates its partial and progressive implementation, as well as the distribution of responsibilities among different actors, their integration under a common framework is important to fully address the variety of needs and to identify the different components of action. The effective implementation of each task (in particular Tasks 1, 3, 4 and 5) requires direct interaction with local actors to better exploit their specific needs and limitations, as well as their potential contribution to each Task.

The Tasks identified are the following:[15]

Task 1 – Seminar "The Role of Statistics and Indicators in S&T Policy-Making in SEE"
Task 2 – Training Workshop on S&T Statistics and Indicators
Task 3 – Expert Visits
Task 4 – Regional Cooperation on S&T Statistics and Indicators
Task 5 – Dissemination
Task 6 – Research Programme

Task Description

TASK 1
Seminar – "The Role of Statistics and Indicators in S&T Policy-Making in SEE"

This Task consists of the organization of a Seminar directed both for science policy-makers and statistical officials in the Region. It includes presentations from both local actors as well as a limited number of international experts.

The Seminar should have as its main objectives:
- raising the awareness of policy-makers for the need to support the development of S&T statistics and indicators;
- discussing the specific needs of indicators for policy-making, that can guide statistical and indicator work;
- presenting recent developments in S&T statistics and indicators;
- discussing organisational models for S&T statistics production and dissemination, including publicly available databases;
- generally improving the dialogue decision-makers and statistical officials.

[15] Some activities proposed here have already been partially developed or partially proposed by other local actors. In particular, a project proposal from the Albanian Center for Science, Technology and Innovation Policy includes a similar set of objectives concerning the S&T Statistics and Indicators Systems.

This Seminar should be able to bring together different types of participants:

- high-level S&T policy-makers;
- heads of statistical offices;
- technical staff from statistical offices;
- STI researchers;
- other local stakeholders, from the research and innovation system;
- international organisations.

The participants will be mostly from the SEE countries. However, each country will not be necessarily represented at all these levels, with such a seminar aiming to involve around 50 participants.

The Seminar should be organized to last one full day, starting after lunch time on Day 1 and ending with lunch on Day 2, to facilitate travel and include time for informal discussions, central to the development of an informal network between the participants.

The program of the seminar should balance national presentations of the S&T statistical system, presentations of the state of the art, and round-tables focusing on policy-making concerns and regional cooperation issues. A possible preliminary program follows, with indicative titles and participants of the sessions. A slightly different agenda could be organized including one or two parallel sessions, for specific audiences, with the main sessions contributing to bridging the different participants and a final session including reports from the parallel sessions. Invited experts, national and international, should contribute to moderate the panels and for the development of the final conclusions.

Although the seminar should be organized in the English language, consideration should be given to potential limitations thereof and the eventual need to support translation costs.

Duration:

- 2 Days - Seminar
- 4 Months - Preparation

Participants:

- 50 Participants (high-level S&T policy-makers; heads of statistical offices; technical staff from statistical offices; STI researchers; other local stakeholders, from the research and innovation system; international organisations)
- 2-3 International Experts

SEMINAR – Possible Agenda
(indicative titles only)

Day 1

- Introduction and Objectives of the Meeting
- Recent developments in the production of S&T statistics and indicators in SEE countries (presentations from 3 Statistical offices, 15 min each plus round-table discussion)
- S&T policy-making: Main data needs (presentations from political officials – e.g. Junior Ministers or Heads of Research Councils from 3-4 countries, 15 min each plus discussion)
- Invited Lecture – S&T Indicators post-Frascati: recent developments and future research agenda

Day 2

- The production of S&T statistics: main difficulties (round-table including statistical officials, data providers, including research institutions, and STI researchers)
- Experiences of regional and international cooperation in S&T statistics (presentations from International Organisations and Heads of Statistical Offices, 15 min each plus round-table discussion)
- Invited Lecture – Organisation of S&T statistics and indicators: National needs and international harmonization
- Conclusions and Follow-up

TASK 2
Training Workshop – "S&T Statistics and Indicators: New Developments"

This Training Workshop would correspond to a 3-4 day workshop specifically dedicated to the technical officers responsible for S&T statistics in the SEE countries. It should be led by S&T statistical departments of UNESCO and other international organisations, namely OECD and EUROSTAT, by a researcher in the field of Innovation Studies and by local experts. Participation from one or two leaders of S&T statistical departments in leading EU countries could also be envisioned, as these have to deal directly with the activities of launching surveys, and collecting other statistical data, and could also open doors for further bilateral cooperation.

Such training seminar should focus on

1. Human Resources Statistics and related data (e.g. training, mobility, registries)
2. R&D expenditures and related data (e.g. GBAORD, public funding)
3. S&T Output data (e.g. Patents, Publications, Innovation)
4. Knowledge-based economy indicators (e.g. TBP, High and medium-tech sectors, KIBS)

The first two are traditional Frascati data, and although these are already being applied, to different degrees, in the countries surveyed, there are several "details" (for example to do with translation issues, and the amount of information made available to respondents) which are important to discuss on their implementation and which have impacts in the quality of the data collected and publicly presented. It is important that these methodologies become more stabilised. Nevertheless it is also important to move ahead towards new indicators, often based on publicly existing information. An additional point/day could focus on 'Development of New Indicators'.

Each topic should focus mostly on methodological questions regarding the collection and production of statistical data and related indicators, on its use in studies of the research and innovation systems, on its use for policy-making and on critical approaches to the concerned data. The workshop should make wide use of case-study material.

This training seminar should be limited to 20 participants. Each participant should be requested beforehand to contribute with one presentation from a list of previously identified themes/papers/national cases.

The working language of the Training Workshop should be English.

Duration:

- 4-5 Days - Workshop
- 6 Months - Preparation

Participants:

- 20 Participants (Technical officials responsible for S&T statistics in the National Statistical Offices or within the Ministries for Science and Technology)
- 4-5 International Experts

TASK 3
Expert Visits

This Task has as main objective the contribution to the development of the national systems of S&T statistics and indicators production, and of their harmonization with other international developments. While Task 1 focuses on the interaction between statistics and indicators producers and policy-makers as users, and Task 2 aims to train technical staff, both with a very limited number of participants from each country, this Task aims to open up the wider S&T statistical system to analysis.

The present Task consists of the organization of missions by foreign experts to the SEE S&T statistical systems, to work intensely with the local staff, reviewing processes and discussing the main limitations and potential improvements. The presence of foreign experts should also contribute to draw the attention of high-ranking officials to the central issues regarding the quality and use of the local statistics and indicators.

It is important that these experts can visit more than one country. The visits of the experts should be on average a week long. In view of further regional cooperation (see also below Task 4), these expert visits could also be constituted both by an international expert and by an official from another country in the region with responsibility for S&T statistics and indicators. This can strongly contribute to the intra-regional learning in this area.

Duration:
- 5 Days - Visit
- 4 Months - Preparation and Reporting (per visit)

Participants:
- 1-2 International Experts in interaction with local stakeholders (per visit)

TASK 4
Regional Cooperation on S&T Statistics and Indicators

This Task focuses on the development of a regional network on S&T statistics and indicators. The Task should be developed in parallel with the implementation of Tasks 1 to 3, but with a longer term focus and the objective of being strongly promoted by the national bodies.

Regional cooperation is of particular importance. On the one hand, there are often very similar questions regarding the development of S&T systems among the countries in the region. On the other hand, there are different degrees of development of these competences, which learning processes should exploit. Regional cooperation can contribute to identify the main issues and limitations as well as to exchange experiences regarding the development of the main S&T statistical competences. This regional cooperation should include at its centre the exchange of information, but should also aim to foster other forms of cooperation, namely through regular meetings.

Following an earlier Regional Workshop, held in Sofia during November 2003, a 'Working Group on S&T Indicators and Statistics for S&T Policy-Making in South-East European Countries' was established, although its effectiveness has been limited since. Such regional cooperation activities could be based on the support of a (bi-)annual meeting of the existing Working Group, supported by a more permanent communication network.

These meetings should include an annual follow-up of the results of activities developed in other Tasks. Some results of other activities should be an important input to the meetings, while at the same time the network developed through this Task should actively contribute to the organization of other Tasks. Task 4 should also foster further bilateral or multi-lateral cooperation within the region, for exchange of know-how and for benchmarking statistical procedures.

This Task aims to contribute to improve policy coordination for S&T statistical and indicator development in the region, with the objectives of exchanging information, developing common actions, coordinating procedures and outputs and, eventually, commissioning comparative research for the region. Such a network could eventually be supported under the present ERA-NET scheme, of the European Commission, with a rotating coordination between SEE Countries.

Duration:
- 1 Day - Meeting (annually)
- 6 Months - Preparation of information network
- 2 Days per month – Maintenance of information network

Participants:
- 1 Representative per country participating in the Meeting, supported by an information officer;
- Network to have an annually rotating coordinator.

TASK 5
Dissemination

The importance of S&T statistics and indicators as a strategic planning tool must be shared by the different stakeholders, and not only by policy-makers. Achieving a wider recognition of the importance of these tools is also an important contribution to overcome some of the limitations in the production of official statistics, as the collection of data often faces lack of knowledge by different respondents.

In this way, this Task aims to raise the awareness about S&T statistics and indicators and the relevant methodologies. Besides the awareness raising on this subject directly with local statistical and science policy-makers, it is important to involve other stakeholders and research performers.

The production of small booklets, in local languages, directed towards presenting the main statistics and indicators, with short definitions and examples, based on the existing Frascati-type

manuals could contribute for further awareness of the performers, for their improved research accounting systems and for greater support to the need of strengthening the area of S&T statistics. Such booklets should be distributed among all institutions within the research and innovation system.

Two other areas of dissemination are the production of Annual S&T Reports and the public availability of data and databases through the official webpages. The further development of these modes of dissemination, already largely in place, is of particular importance for the strengthening of these systems and for improving the dissemination and access to data and methodologies.

Duration:
- 6 Months-1Year - Preparation of booklets

Participants:
- National Statistical Offices and Ministries of Science and Technology

TASK 6
Research Programme – 'S&T Policy and S&T Indicators'

Task 6 focuses on the medium-term development of capabilities in S&T statistics and indicators through the organization of a small research programme on 'S&T Policy and S&T Indicators'. This Task recognizes the importance of research as a central mechanism of knowledge production. It also recognizes that the use of S&T statistics are not limited to policy-making. They are also a tool that contributes to the steering of the research system more widely, and are in constant evolution.

The existence of research activity in this field is essential to guarantee the development of a critical approach to the quality and reliability of the official statistics, through the eye of the users. This research programme could also contribute to develop areas of research, through indicators, which cannot yet be fully developed through the statistical offices. These could range from S&T indicators and research evaluation, university-industry links, sectoral innovation dynamics, studies of career trajectories, bibliometric and scientometric analysis, the development of the knowledge-based economy in the SEE countries, public project funding.

The development of such a research programme has three main objectives:
- to highlight the usefulness of S&T indicators for our understanding of a changing economy;
- to highlight the dynamic nature of these statistics and indicators;
- to contribute to the advanced training of human resources on S&T statistics and indicators.

It is important that this Task be developed through a collaborative initiative at the regional level, with the participation of research groups in a significant number of SEE countries, to achieve both a wide comparative analysis and a significant training component, which can benefit greatly from international collaborative ventures. Internationalisation activities of

the researchers involved, beyond the participating countries, should be eligible and strongly encouraged.

The research programme should be developed on a competitive basis, based on international peer review processes, aiming to fund a reduced number of projects, with a small budget allocation (funding only additional costs), with each project lasting for a period of at least two years. Such programme could be developed through multi-lateral cooperation processes, with financial input depending on the participation of national institutions, or with the support of international organizations, such as the European Commission.

Duration:
- 1 Year – Preparation (Annually)
- 6 Months - Evaluation
- 2 Years – Project execution

Participants:
- Researchers in Science, Technology and Innovation Studies

Potential Funders

These activities can be funded from a variety of sources including primarily international organisations (UNESCO, European Commission, OECD, NATO Science Programme).

National Governments can have a particular role through the support of the participation of their own staff and other nationals in the meetings scheduled. The extent of regional cooperation will also depend on the willingness of national bodies to actively promote such collaborative activities. The development of an ERA-NET on this topic, with the relevant local stakeholders would be a very important contribution to the development of these activities.

The strong S&T dimension may also lead other Foundations to contribute to the organisation of this plan of activities.

Governance

It is important that a variety of local institutions must be involved in both the organisation and the activities themselves. The coordination of the different Tasks should be distributed among the different SEE countries relevant institutions.

The invited experts to the different activities should constitute together an advisory council which can review, assess and provide advice and recommendations regarding the activities and objectives of the present proposal.

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Enhancing Science Policy and Management in South Eastern Europe

Science and Technology Statistics and Indicators Systems

This publication presents the results of a Pilot Study conducted on behalf of the UNESCO Office in Venice – UNESCO Regional Bureau for Science and Culture in Europe (BRESCE) by Dr. Tiago Santos Pereira of the Coimbra University in Portugal. It includes an analytical report concerning the state of the art of the production, from the qualitative and quantitative points of view, of Science and Technology (S&T) statistics and indicators in Albania, Bosnia and Herzegovina, Bulgaria, Croatia, the former Yugoslav Republic of Macedonia, Montenegro, Romania and Serbia. A set of conclusions and recommendations, as well a comprehensive project proposal for future activities to be undertaken at national, regional and international levels are equally presented.

This report is part of UNESCO's strategy for *Enhancing Co-operation with South Eastern European Member States*.

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