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联合国教育、
科学及文化组织

**Natural Sciences Sector**
**Division of Science Policy and Capacity Building**

**Concept Paper**

# UNESCO´s Global Observatory on Science, Technology and Innovation Policy Instruments

# GO→SPIN

**Paris, October 2011**

# Abbreviations

| | |
|---|---|
| **CEPES** | **UNESCO European Centre for Higher Education** |
| **GO→SPIN** | **Global Observatory on Science, Technology and Innovation Policy Instruments** |
| **GTZ** | **is now GIZ - Deutsche Gesellschaft für Internationale Zusammenarbeit** |
| **IADB** | **Inter American Developing Bank** |
| **ICT** | **Information and Communication Technologies** |
| **IDRC** | **International Development Research Centre** |
| **IEC-UNQui** | **Instituto de Estudios Sociales de la Ciencia, Universidad Nacional de Quilmes, Argentina** |
| **IESALC** | **UNESCO International Institute for Higher Education in Latin America and the Caribbean** |
| **IICBA** | **UNESCO International Institute for Capacity Building in Africa** |
| **IIEP** | **UNESCO International Institute for Education Planning** |
| **IITE** | **UNESCO Institute for Information Technologies in Education** |
| **LAC** | **Latin America and the Caribbean** |
| **MLA** | **Main Line of Action** |
| **NCR** | **National Research Council (USA)** |
| **NSF** | **National Science Foundation (USA)** |
| **OAS** | **Organization of American States** |
| **OECD** | **Organization for Economic Co-operation and Development** |
| **OEI** | **Organization of Iberoamerican States** |
| **RICYT** | **Iberoamerican Network on Science and Technology Indicators** |
| **SACMEQ** | **Southern and Eastern Africa Consortium for Monitoring Educational Quality** |
| **SPIN** | **Science Policy Information Network** |
| **SPINES** | **Science and Technology Policies Information Exchange System** |
| **SC/PCB** | **UNESCO Division of Science Policy and Capacity Building** |
| **S&T** | **Science and Technology** |
| **STI** | **Science, Technology and Innovation** |
| **STIGAP** | **Science, Technology and Innovation Global Assessment Programme** |
| **STP** | **Science and Technology Potential** |
| **STPI** | **Science and Technology Policy Instruments (IDRC)** |
| **TIS** | **Technology Intelligence Studies** |
| **UNCTAD** | **United Nations Conference on Trade and Development** |
| **UN-ECLAC** | **United Nations Economic Commission for Latin America and the Caribbean** |
| **UIS** | **UNESCO Institute for Statistics** |
| **UNESCO** | **United Nations Educational, Scientific and Cultural Organization** |
| **UNISIST** | **United Nations Information System for Science and Technology** |
| **UNU-MERIT** | **United Nations University Maastrich Economic and Social Research Institute on Innovation and Technology** |
| **WB** | **World Bank** |

# UNESCO´s Global Observatory on Science, Technology and Innovation Policy Instruments (GO→SPIN)

**SUMMARY:** The Global Observatory on Science, Technology and Innovation Policy Instruments (GO→SPIN) is a revolutionary cluster of databases equipped with powerful graphic and analytical tools. The pilot platform which is already in operation has been devised for decision-makers and specialists in science, technology and innovation (STI) policies. GO→SPIN has the potentiality to be the first global observatory on STI policies that might provide end-users information on the structures of the national systems of science, technology and innovation; descriptions of STI national priorities and goals; STI legal frameworks; STI policy instruments; international cooperation strategies; long-term temporal series of indicators on STI activities, innovation surveys, gender, economy, energy, environment, governance, social issues, among others. The pilot-platform also includes: a database module with descriptions about the topics and requirements needed to apply to more than 170 STI international cooperation agencies and organizations; a digital library module with UNESCO documents and books specialized on STI; a country profiler analytical tool that combines –at national and regional levels- all the information available at the platform with other external sources and a search machine that allows the exploration of the whole platform using keywords. A description of the increasing demand for information about STI policies worldwide, STI policy instruments, Technology Intelligence Studies (TIS), STI indicators and foresight studies to develop medium and long term STI strategies is presented. The need to develop a new standard-setting instrument to recommend to Member States a methodology for normalizing and standardizing the information on STI policies and policy instruments is recognized. A proposal to develop the "Paris Manual" is made. A strategic partnership between UNESCO and the European Commission to harmonize the ERAWATCH and GO→SPIN platforms is analysed and formulated. Lastly, a project description to expand the pilot-platform from the present Latin America and Caribbean regional coverage to Africa, Arab States and Asia-Pacific regions is presented. A Global Observatory on Science, Technology and Innovation Policy Instruments might increase the visibility and presence of UNESCO within STI decision-maker units and experts on STI policies all over the world. Its potential visibility might transform this platform into a flagship project for the Division of Science Policy and Capacity Building (SC/PCB).

## 1. Introduction

Science, technology and innovation (STI) activities are becoming increasingly important for social, economic and sustainable development. During the last 60 years, both developed and developing countries have recognized this fact by increasing the number of STI governmental bodies, by establishing new STI legal frameworks and by implementing a diverse set of new STI policy instruments. These actions resulted in an expansion of investment in scientific research, technological development and innovation; an increase in the number of scientists and engineers; and an exponential growth in the number of new scientific articles and patents worldwide (UNESCO, 2010b).

The formulation of adequate STI policies is critical in several areas, such as mitigating the consequences of global climate change; exploring new energy sources; generating innovation to foster social inclusion; promoting the sustainable management and conservation of freshwater, terrestrial resources and biodiversity as well as disaster resilience. These instruments can also be adequately designed to achieve the UN Millennium Development Goals (MDG) and to foster the eradication of extreme poverty (UN Millennium Project: Task Force on Science, Technology and Innovation, 2005).

STI policy debates are not yet dominated by a thoughtful, evidence-based analysis of the likely merits of different investments and policy decisions are strongly influenced by past practice or data trends that may be out of date (Husbands Fealing *et al,* 2011). The evolution of new policies has been accompanied by more difficult challenges in their planning and evaluation and that this indicates the need to improve the theoretical frameworks for policy formulation (Steinmueller, 2010).

Recently, Flanagan *et al* (2011) have explored the ways in which innovation policy studies treat actors, instruments, institutions and interactions in order to be able to arrive at more useful conceptualisation of the policy mix for innovation, stressing the need for a genuinely dynamic view of policy formulation and policy interaction. They concluded that "despite the importance attached to 'strategic policy intelligence' in recent innovation policy analysis, little empirical attention has been devoted to actual processes of policy learning." In developing and exploiting technological opportunities, institutional competencies (i.e. the governance of STI decision-making bodies), are just as important as the STI incentive instruments they promote (Pavitt, 1996). Path dependency emerges as costs for STI institutional changes are often higher than the accommodation of new instruments and policies to existing structures (Van der Meulen, 1998). For these reasons, the analysis of any national STI policies will strongly depend on the adequate mapping of the structure of the STI governing bodies, of the STI national legal framework and on the implicit and explicit operational STI policy instruments.

STI projects normally occur within a larger temporal framework administered by an organization or an STI governmental policy body. The early stages of a new STI policy usually appear as successive expansions of the group of agents and stakeholders whose endorsement is needed to launch the initiative, while the later stages focus on

the management of the programme, feedback about its success or failure at the policy level (Marburger III, 2011). For these reasons, in order to provide an accurate landscape of the STI policies and policy instruments within a specific national context, it is imperative to understand "the long-term evolution" of the STI organizational chart, STI infrastructure and legal framework (i.e. explicit policies). The latter must be contrasted with detailed analysis of the long-term behaviour of political, educational, economic, productive and social macro variables (i.e. implicit policies).

Policymakers need to have a better picture of their national, regional and global performance with regard to the distribution of knowledge and to estimate the magnitude of the loss of potential innovation due to the limitation of the STI policy instruments which are applied. In this context, a better understanding of the long-term evolution of STI policy institutions and organizations as well as their governance characteristics is also needed.

Accurate data are required to describe the current state of STI policies around the world and the information should be presented in such a way as to allow the decision-makers and experts to estimate whether this state meets societal needs or expectations. Policymakers would benefit from additional policy tools to assist in allocation decisions or in the design of new STI policy instruments, especially if they are real-time tools or new innovative prospective methodologies[1]. Recent empirical studies show the relevance and long-term impact of appropriate STI information services on STI policies to improve the national competitiveness (Yun-Seok and Jae-Sung, 2009). It is, at this time, the duty of organizations in the United Nations family to assist states in this matter. To be fully effective, such assistance should take the form of a concerted effort by those international organizations with similar mandates and goals.

*UNESCO´s Global Observatory on Science, Technology and Innovation Policy Instruments* (GO→SPIN) is an initiative fostered by the Division of Science Policy and Capacity Building (SC/PCB) to generate reliable and relevant information about the different landscapes of STI policies around the world, which is a mandate established

[1] Recent developments in the mathematical theory of networks can be applied on the formulation of new STI policies in order to promote strategic innovation within national economies. Hidalgo *et al*. (2007) found that: "Economies grow by upgrading the products they produce and export. The technology, capital, institutions and skills needed to make newer products are more easily adapted from some products than from others. The study of this network of relatedness between products, or "product space," shows that more-sophisticated products are located in a densely connected core whereas less sophisticated products occupy a less-connected periphery. Empirically, countries move through the product space by developing goods close to those they currently produce. Most countries can reach the core only by traversing empirically infrequent distances, which may help to explain why poor countries have trouble developing more competitive exports and fail to converge to the income levels of rich countries." This type of analysis has a direct application to the formulation of customized STI policy instruments for developing specific technologies, where the country has detected a potential new technological niche. The access availability to new electronic international databases (Zucker and Darby, 2011) combined with the appropriate analytic software might transform this type of analysis into a standard procedure in order to select STI national priorities. These are the tools that GO→SPIN is seeking to develop in the future.

by the organization´s Medium-Term Strategy 2008-2013[2]. The platform provides an innovative cluster of databases equipped with powerful graphic and analytical tools that has been devised for political leaders, planners, directors and administrators of science and technology in governments, parliaments, universities, research institutions, production enterprises concerned with innovation, international organizations working for development; research workers and specialists whose field of study embraces science and technology policies. The platform is also a useful tool for the democratization of decision-making and public accountability on STI policies. Promoting knowledge societies, enhancing the effectiveness of democracy and democratic institutions, providing the public with opportunities for effective public deliberation, promoting transparency, accountability, responsiveness, engagement, inclusiveness, accessibility, participation, subsidiary and social cohesion, is part of the mandate committed to UNESCO[3].

The GO→SPIN platform will be used to report all the outputs, technical reports, country assessments and analyses from the SC PCB programmes. Examples of them are: the Science Governance and Legislation Programmes, University-Industry Partnerships, STI Policy Reforms, Science and Technology Education and the Science, Technology and Innovation Global Assessment Programme (STIGAP). For example, STIGAP envisages the setting up of regional networks all over the world. These networks will bring together researchers and research institutions of the member states in an effort to assess the development of STI in their respective countries in way that is locally relevant. It foresees the channelling of funds to these national researchers and research institutions for capacity building and for data collection and the organization of regional workshops for the presentation of STI assessments, analyses and policy briefs.

STIGAP will contribute to GO→SPIN in three ways:

- The STIGAP workshops will serve as a forum for the dissemination of the Paris Manual whereas outcomes of the analyses under STIGAP may feed the on-going revision of this manual as far as indicators are concerned;
- GO→SPIN training seminars will be combined with STIGAP regional seminars so that the partners in STIGAP can also become partners in GO→SPIN; and

[2] The XII UNESCO´s General Conference held in Paris in 1962 established the organisation´s mandate to: (a) Collect, analyse and disseminate information concerning the organization and financing of scientific research in Member States; (b) undertake surveys and studies on the national science policy of Member States; (c) organize meetings of experts to recommend objectives and methods of planning in national science policy; and (d) help Member States, upon request, in improving and developing their national scientific policy and institutions (UNESCO, 1963). This Mandate evolved over the years and now is part of the *Strategic Programme Objective 4: Fostering Policies and Capacity-Building in Science, Technology and Innovation*, described at the 34/C4 Medium-Term Strategy 2008-2013 (UNESCO, 2008). The GO→SPIN platform is a new SC PCB initiative to fulfil UNESCO´s Mandate using an innovative technology and methodology to collect and standardize information on STI policies worldwide.

[3] *Report by the Director-General on UNESCO's Activities for the Implementation of the World Summit on the Information Society (WSIS) Outcomes and Future Measures for Reaching its 2015 Goals*, 36 C/52, General Conference 36th Session, UNESCO: Paris, 2011.

- Data and documents collected under STIGAP will be incorporated into the GO→SPIN database whenever relevant.

GO→SPIN will also enhance STIGAP:

- Data and documents made available through GO→SPIN will feed the discussions and analyses of the national research groups and regional networks that build up STIGAP;
- The training provided under GO→SPIN will support the capacity building effort under STIGAP; and
- This training will provide more body to STIGAP activities and in this way help to solidify the STIGAP networks.

The co-design of both initiatives confirms the integrated perspective of SC/PCB on worldwide STI data collection and analysis.

The GO→SPIN initiative is promoting an *intersectoral* approach for the preparation of the activities and outputs, for the definition of guidelines and methodologies and for STI production of information and on-line publishing strategies. The Social and Human Sciences Sector (SHS) will participate in analysing the SHS policy instruments, by developing the web-semantics and text mining tools and by taking part in the conceptual development of STI policy assessments around the world. The Communication and Information Sector (CI), in collaboration with UNESCO Institute for Information Technologies in Education (IITE), will provide guidelines for transforming the GO→SPIN platform into a genuine tool for the promotion of a global Knowledge Society, as well as using it to include the outputs of some of their projects and studies. The UNESCO Institute for Statistics (UIS) will be responsible of providing GO→SPIN with accurate statistics on science, technology and innovation; education; communication and information and culture. The UNESCO International Institute for Educational Planning (IIEP) will provide accurate analysis, studies and surveys on the relation between Academy and Industry. The UNESCO International Institute for Higher Education in Latin America and the Caribbean (IESALC), UNESCO European Centre for Higher Education (CEPES) and UNESCO International Institute for Capacity-Building in Africa (IICBA) will provide reports about higher education policies within Member States and about the implementation of research policy instruments among universities worldwide.

The GO→SPIN initiative fulfils the five established functions of UNESCO:

(i) **Laboratory of ideas:** the GO→SPIN platform applies innovative technologies to provide decision-makers with accurate information about STI policies around the world.

(ii) **Standard-setter:** the GO→SPIN platform is establishing through the "Paris Manual" new ways to standardize and normalize information about STI policies that can be easily replicated by its Member States and might be used by other similar initiatives around the world.

(iii) **Clearing house;** the information generated by the GO→SPIN platform will be available for free via internet for any potential user in the world.

(iv) **Capacity-building**: the Division of Science Policy and Capacity Building will implement a training programme for the collection, generation and improvement of information on national STI policies for experts, decision makers and governmental managers around the world.

(v) **Catalyst for international cooperation:** GO→SPIN will be used to promote South-South and North-South-South cooperation on STI policies among Member States.

## 2. SPIN as a prototype for GO→SPIN

In 2010, UNESCO´s Regional Bureau for Science in Latin America and the Caribbean[4] (UNESCO Montevideo) developed a pilot methodology for the standardization and systematization of data on STI policies in the 33 countries of Latin America and the Caribbean (LAC), together with a sophisticated information platform that was originally named *Science Policy Information Network* or **SPIN** **<http://spin.unesco.org.uy/>**, which included:

- A detailed inventory of each national innovation system in the region, with a description of their institutional structure and details of their main programmes, priorities, performance, planning and strategies for international co-operation.
- A database encompassing all the relevant STI legal frameworks for each country.
- An inventory with detailed descriptions of more than 650 different technical and financial STI policy instruments implemented in Latin America and the Caribbean. These policy instruments are divided into 9 categories by objectives and strategic goals, into 11 categories by type of facility and into 18 categories by type of beneficiary.
- A country profiler tool which combines all the STI information about each country (and also at regional level) is available at SPIN, with links to official national

[4] The SPIN platform was developed by a handful of experts with a very small budget taken from UNESCO´s Regular Programme. This was done following the mandate of the Member States established at the 35/C5, MLA1, ER3, for the biennium 2010-2011. The architecture of the SPIN platform, the organization of information and the methodology for systematization of the data were designed by Guillermo A. Lemarchand, UNESCO Senior Consultant for the Basic and Engineering Sciences Programme (SC/BES) and for the Science Policy and Sustainable Development Programme (SC/PSD) at the Regional Bureau for Science of UNESCO for Latin America and the Caribbean (2008-2010), with the assistance in their development and implementation of Martin Vieira Dieste, UNESCO Assistant Consultant (2009-2010). The SPIN database software was developed by Jorge Gomez from ENTAL SA, a software company in Uruguay. The system engineering work done on UNESCO´s server was performed by Eduardo Trapani (Web Master UNESCO Montevideo). The website design was realized by Maria Noel Pereyra (Website Clerk, UNESCO Montevideo). At different stages, the team was benefited by the very valuable help of Paula Santos (Programme Assistant, Montevideo Office). The *State Planet* software is protected by copyright and other intellectual property rights. This software was developed by Frank van Cappelle. Since December 2010, SPIN LAC is under the supervision of Ernesto Fernández Polcuch, SC/PCB Senior Programme Specialist at UNESCO Montevideo.

documents on STI policies, access to other databases and STI country reports, studies by National Academies of Science, etc.

- A powerful geo-referenced analytical software (Stat Planet) which includes more than 450 temporal series, some of them ranging from 1950 to the present time. These time series encompass different groups of indicators: economic, social, governance, gender, environmental, ICT and STI. The evolution of different indicators can also be studied over time and compared with other regions or countries to allow decision makers and specialists to detect different patterns in the data in order to develop prospective studies.
- A database containing 170 descriptions of national and international organizations and other NGOs which provide technical and financial co-operation in science and technology. These institutions are classified by area and type of co-operation, geographical focus and type of beneficiary.
- A digital library specializing in STI with over 800 titles produced by UNESCO.

The GO→SPIN programme is an initiative promoted by the Division of Science Policy and Capacity Building in the Natural Sciences Sector of UNESCO. The aim is to expand the SPIN platform into other regions of the world, including Africa, Arab States and Asia-Pacific.

## 3. Improving STI National Assessments by Analysing long-term STI Trajectories

As shown in §1, it is crucial to understand the long-term evolution of STI policies, policy instruments and organizational behaviour, in order to produce an appropriate national STI policy assessment. UNESCO has produced hundreds of STI surveys and country assessments that might be valuable in re-constructing the national and regional STI trajectories.

Here we present a list of the fundamental milestones achieved by UNESCO with regard to international surveys on STI policies[5]. It was in 1952 that the activities of the Department of Natural Sciences with regard to science policy and the organization of research were initiated (UNESCO, 1966). In 1954, UNESCO undertook the first survey of the national research centres and councils in Member States. Subsequent editions included a list of the national bodies responsible for formulating the science policies, the research centres and the academies of sciences (UNESCO, 1963). The first recommendations suggesting that Member States should undertake normative actions related to science policy to organize scientific research at the national level were made in the early sixties[6].

[5] Kotchetkov (2005), Hillig (2006) and Padirac (2006) present brief descriptions with the most relevant activities of UNESCO's Science Policy Division.

[6] The Social and Human Sciences Sector of UNESCO had also been very active producing surveys about the state of development of institutions in the social sciences around the world, such as: *International Repertory of Sociological Research Centres* (1964), *Social Sciences in Asia* (1976, 1977, 1980), *Directory of Social Sciences Institutions in Central and Eastern Europe* (1995), *Directory of Social Sciences Institutions*

Following the recommendations of the UN General Assembly, in 1961 UNESCO published an international report on "Current Trends in Scientific Research" (Auger, 1961). As early as 1965, the Division of Science Policy at UNESCO also developed a methodology to standardize all the information concerning national STI policies (UNESCO, 1965, 1966 and Hemptinne, 1972). These comprehensive surveys of the national scientific and technological potential (STP) constitute the factual data base for science policy-making purposes. They consisted of the periodic collecting, updating and analysis of comprehensive data on the overall resources at the disposal of a given country for its scientific and technological activities. These data were administrative, functional, operational, structural or statistical in nature, in relation to all the scientific and technological units of the country. This methodology was also implemented to make regional country surveys (for each Member State of the corresponding region): 6 in LAC; 5 in Africa; 2 in the Arab States and 1 in Asia. The methodology was also applied to produce 11 individual country reviews in Europe-USA and 6 in Asia. All these reports were published between 1965 and 1990 within the series on "Science Policy Studies and Documents." The methodology was improved and updated several times until 1982 (UNESCO, 1982).

In 1969, UNESCO published "The Measurement of Scientific and Technological Activities: Proposal for the Collection of Statistics on Science and Technology on Internationally Uniform Bases" a book written by the S&T policy pioneer, Christopher Freeman (1969). This appeared almost simultaneously with the publication of the first "UNESCO Manual for Surveying National Scientific and Technological Potential" (UNESCO, 1969). A few years later, the Division published the influential textbook "Science for Development: An Essay on the Origin and Organization of National Science Policies," (Spaey, 1971) which was translated into several languages.

In the early seventies, the Science Policy Division developed two very innovative projects concerning S&T information systems. The first one started in 1967, as a joint study developed by UNESCO and the International Council of Scientific Unions (ICSU). This project was known as United Nations Information System for Science and Technology (UNISIST) and grew out based on the concern that the uncoordinated development of incompatible information systems and services was jeopardizing the international exchange of scientific and technical information (UNESCO, 1971).

The second project began in 1972, with the objective of facilitating the management and international exchange of documents and data having a direct impact on scientific and technological policy –at the level of both government and institutions involved in scientific research and transfer. A feasibility study was conducted for the establishment of a revolutionary "Science and Technology Policies Information Exchange System" or SPINES (see UNESCO 1974). The SPINES scheme was designed to include several national and regional units responsible for information input/output

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*in Africa South of the Sahara* (1995); *Directory of Social Sciences Institutions in the Arab Region* (1996); *Directory of Social Sciences Institutions in LAC* (1996), *World Social Science Report* (2010), *Mapping out the Research-Policy Matrix* (2011), among many other surveys that might be used to understand the diffusion –against time- of the social science centres and policies around the world.

and a central group responsible for computing all the data. This programme was abandoned in 1983[7].

The *SPIN platform* takes his name as a tribute to this early SPINES system developed by UNESCO´s Science Policy Division.

In 1978, the General Conference approved a standard setting instrument which included a "Recommendation Concerning the International Standardization of Statistics on Science and Technology." On the bases of this, UNESCO (1984a) published a "Manual for Statistics on Scientific and Technological Statistics" which represented the harmonization of categories and definitions used by S&T statisticians among Member States. It was followed by the publication of a "Guide on Statistics for Science and Technology" (UNESCO, 1984b), which was intended for the use of specialists in various countries (primarily developing countries) entrusted with the task of collecting, processing and analysing statistical data on science and technology. In view of the specific conditions of developing countries, more attention was given to the methodology requiring a minimum of sophistication, technique and personnel for carrying out this work. For more than 25 years, this remained a fundamental issue. Recently, the UNESCO Institute for Statistics (2010) published a document suggesting a methodological approach to measure the particular characteristics of R&D activities in developing countries and in 2011 the Division of Science Policy and Capacity Building launched the Science, Technology and Innovation Global Assessment Programme (STIGAP).

In 1990, published the last edition of the "World Directory of National Science and Technology Policy Making Bodies" (UNESCO, 1990). This was an ambitious periodic survey which allows the experts to study the emergence and diffusion of new STI organizations around the world.

The *World Science Report* series was launched by UNESCO in 1993. Each report in the series reviews the current state of science around the world, from an organizational and a substantive point of view. Written by authors recognized in their respective fields the report has been published in 1993, 1996, 1998, 2005 and 2010. As a source of information, this work is a guide for all those with an interest in the shape of science and technology around the globe, be they decision makers, practitioners of science, active participants or observers.

Since 2003, the collection on *Science Policy Studies* (new series) has published almost 20 volumes on national and regional STI policy assessments. These were produced by the Division of Science Policy and Sustainable Development (UNESCO HQ), by the UNESCO Regional Bureau for Science and Culture in Europe (Venice) and by the UNESCO Regional Bureau for Science in Latin America and the Caribbean (Montevideo).

[7] Bruno de Padirac (2006) a former UNESCO Director of Science Policy Studies and Information, described some of the arguments raised by some representatives to the General Conference in 1983 to abandon the SPINES project.

## 4. Analytic Units used by the SPIN Platform for Mapping STI Policy Instruments:

A policy may remain a mere rhetorical statement if no means are provided for its implementation or to realize its potential effect. To do this, a number of things may be needed, which we will incorporate under the term *policy instrument*. A *policy instrument* constitutes the set of ways and means used when putting a given policy into practice. It can be considered as the vehicle through which those in charge of formulating and implementing policies actualize their capability to influence decisions taken by others.

The study of public policy instruments in national settings has contributed significantly to the understanding of policy, political systems and relations between state and citizen. Research on policy implementation usually focuses principally on the effects of a specific instrument and a wider reflection on whether the correct instrument has been chosen for the purpose. As far as new governance is concerned, the search for instruments is pragmatic in aim (Kassim and Le Gales, 2010).

An STI policy instrument would be an instrument whose ways and means (or actualized capabilities) include, as a significant component, the manipulation of STI variables. Also, a policy instrument attempts to make individuals and institutions take decisions following the rationality dictated by the collective objectives established by those in power. It is the connecting link between the purpose expressed in a policy and the effect that is sought in practice.

One of the first and more relevant studies on STI policy instruments was implemented in the seventies by the International Development Research Centre (IDRC). The principal objective of the project was to devise ways and means to understand how country's investment in science and technology can be most effectively related to its objectives for industrial development. Sagasti and Aráoz (1976) developed an interesting methodological framework to make the survey and for analysing the science and technology policy instruments (STPI) among ten countries in Latin America, the Middle East, Southern Europe and Asia. The STPI work showed not only that the links between production and technology in most developing countries were often weak or non-existent but also that policies on foreign investment, credit and interest rates, patent and trade regulations, imports and exports, project analysis criteria, market protection and social inequity were much more influential in determining whether and in what direction technical change took place in the economy than all other policies directly aimed at the R&D side of the structure to aid and stimulate innovation (Rath, 1990).

In order to analyse the STI policy instruments, the SPIN platform was organized following the theoretical framework developed by Sagasti and Aráoz (1976). Figure 1 shows its basic structure.

The STI organizational structure or chart usually shows the distribution of responsibilities to implement the policy. Under the term “organizational structure” we may distinguish at least three different levels: (1) Policy planning level (policy design), (2) Promotional level (funding) and (3) Implementation level (scientific research, technological development and productive innovation activities). A few countries also include the assessment or evaluation level.

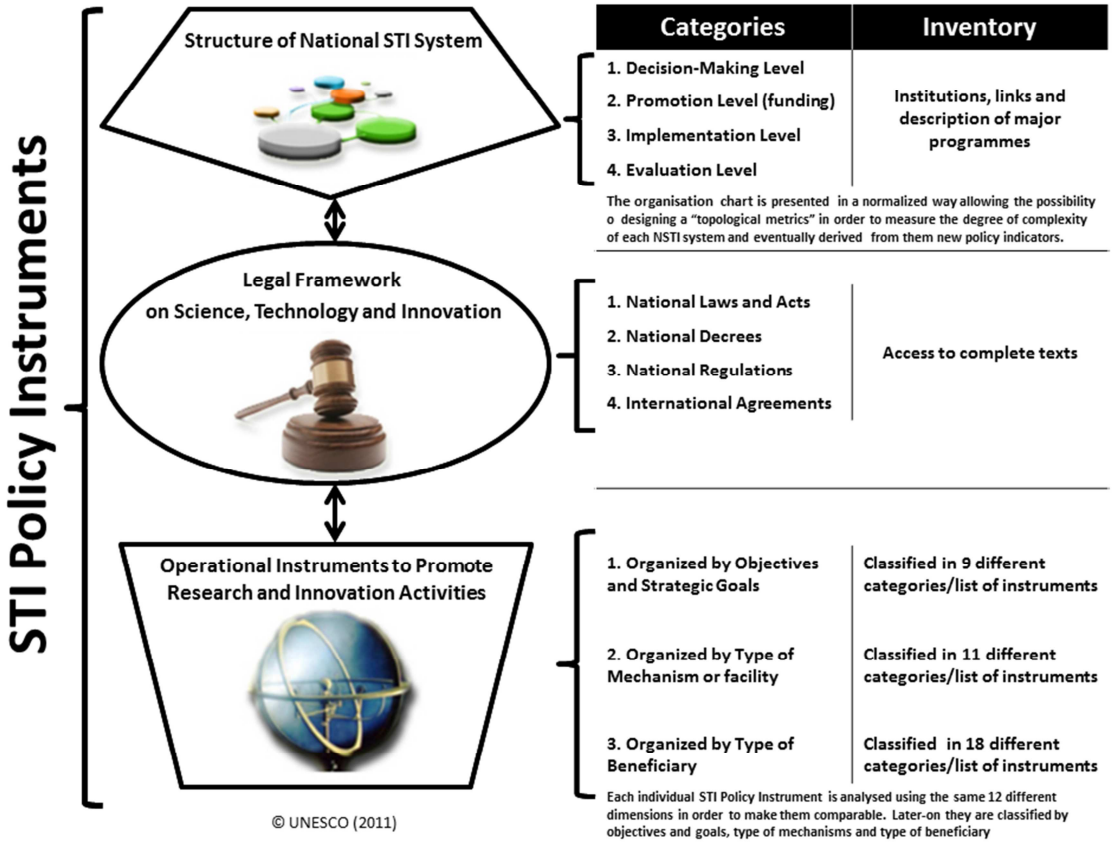
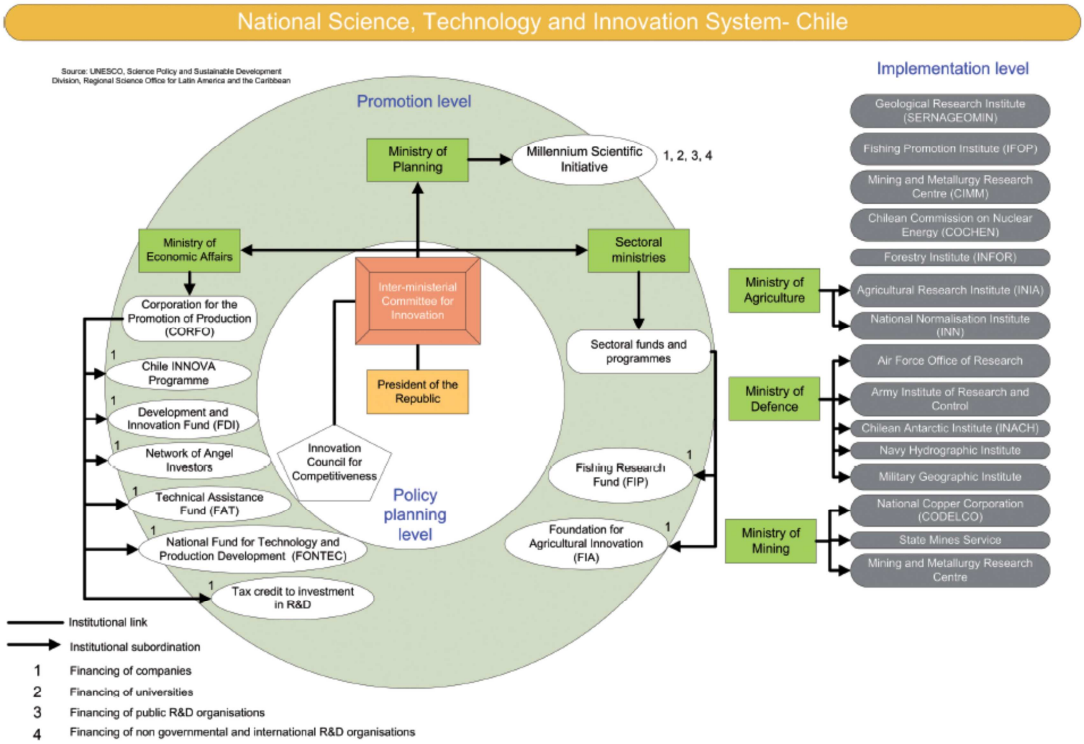



**Figure 1: Analytic units applied at SPIN**

For GO→SPIN, we have introduced a normalized way of coding the different types of organizations and their functions. By representing each national STI organizational chart, using the same set of coding tools (for details see UNESCO, 2010a: p.310), it will be possible in the future to associate them with specific *topological metrics.* The latter will be very useful to define a new set of STI policy indicators applied to understand the level of complexity and functionality of each STI organizational chart. Figure 2 shows a typical example of an STI organizational chart.

The diversity of institutions within the promotion level (funding), in a given country seems to be one of the most fundamental indicators of good practices. The GO→SPIN global database will provide empirical evidences to confirm or refute this and other hypotheses.

The so-called "legal framework" might also be considered as a "legal instrument." This embodies the policy, or parts of it, in the form of a law, decree or regulation. Formal agreements, contracts and international STI cooperation treaties may also be included in this category. A legal device goes one step beyond a "policy" by stipulating obligations, rights, rewards and penalties connected with its being obeyed. GO→SPIN has a friendly platform offering direct access to the whole STI legal framework description and full text of laws, acts, decrees and agreements adopted by each country.



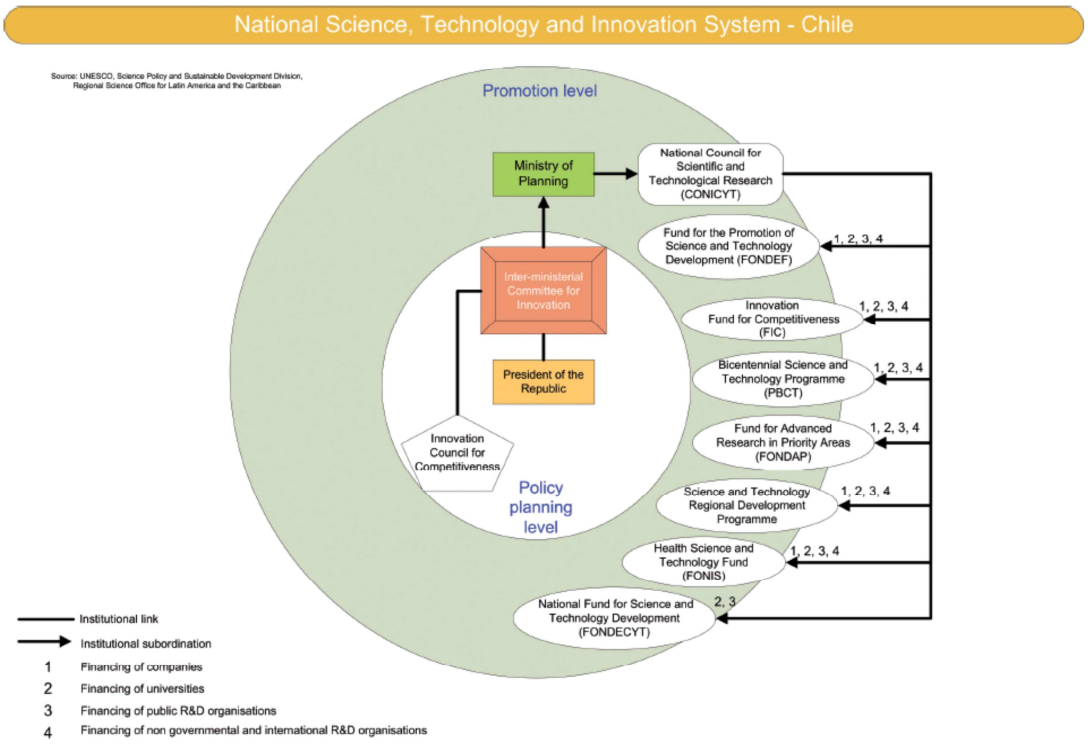




**Figure 2: Example of the STI organizational chart of Chile (2010)**

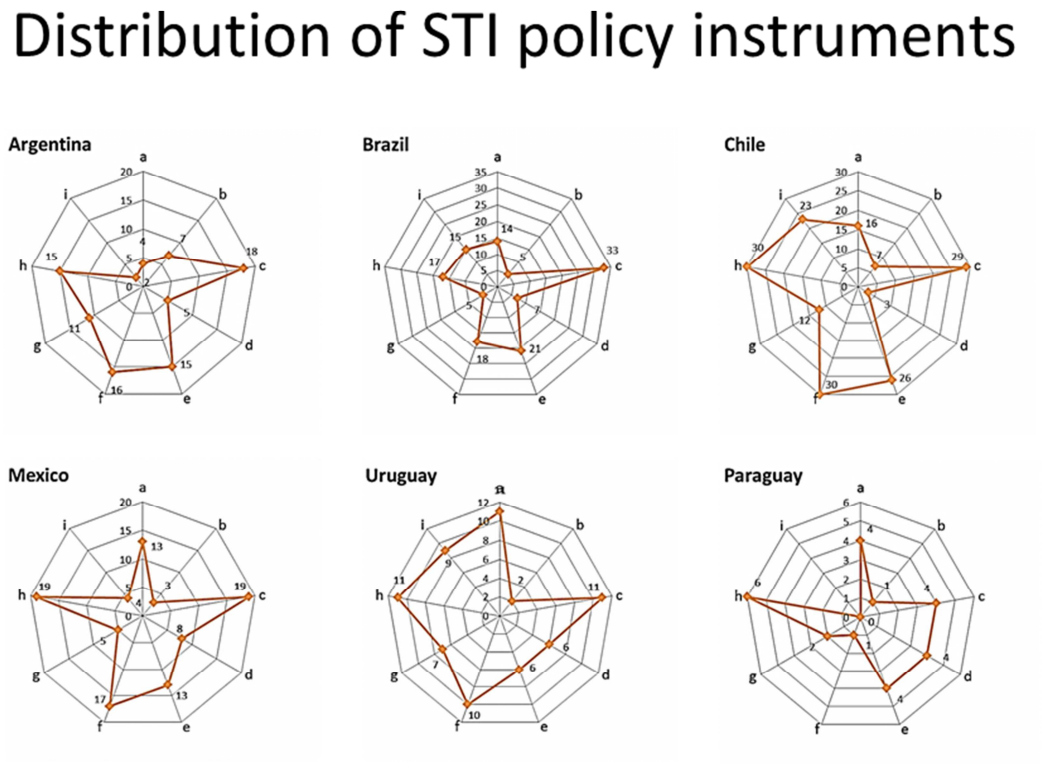



**Figure 3: Distribution of operational mechanisms by objectives and goals, for selected countries using data available at SPIN. After Grandi and Lemarchand (2011)**

SPIN also includes a complete description of "STI operational mechanisms," which are the levers, or actual means, through which the organizational structure ultimately implements the decisions on a day to day basis and attempts to obtain the desired effect on the variables the policy has set out to influence. Throughout the analysis of an instrument it is important to keep in mind the "actors" or key decision-makers who are directly involved in the design and use of a policy instrument. An instrument does not act on its own and responds to the will of the policy-makers and decision-makers using it.

The list of STI operational instruments is divided into three categories: (a) by objectives and strategic goals; (b) by type of facility or mechanism and (c) by type of beneficiary. In order to normalize the analytic information to be provided by each individual operational instrument, SPIN employs a set of 12 different descriptors. The latter were originally designed by Cimoli and Primi (2007) for a system built by UN-ECLAC and replicated by another database developed by the Inter-American Development Bank (IADB) and Centro REDES (Lemarchand, 2008).

Figure 3 shows the distribution of STI policy instruments for different categories of objectives and goals, for a selected number of countries. This is one good example of the potential analytic strength that the SPIN platform has in detecting STI policy

patterns. With GO→SPIN, it might be possible to categorise different countries on a global scale and to evaluate these patterns against the political, economic and societal behaviour of each nation. This information is crucial for producing in-depth analyses of best practices about STI policies for decision-making bodies.

Within SPIN, the contextual factors are analysed by a set of 450 temporal series of indicators. These indicators represent indirect measurements of the country performance resulting from the application of STI "implicit policies" as well as other "explicit" public policies outside the specific STI domain. Some of these datasets span the period from 1950 to 2010. With these long-term temporal series it is possible to estimate the societal behaviour and identify the type of contextual influence that STI policies may have in each country (or region). Table 1 shows the distribution of indicators per topic that can be analysed by SPIN and the Stat Planet software. This module of the GO→SPIN system will be operational "at global level" by the end of 2011.

TABLE 1: Number of time series indicators per topic at SPIN

| | |
|---|---|
| Science and Technology | 175 indicators |
| Economy | 32 indicators |
| Social Issues | 18 indicators |
| Innovation | 47 indicators |
| Energy | 26 indicators |
| Environment | 30 indicators |
| Gender | 76 indicators |
| Governance | 12 indicators |

Stat Planet is browser-based interactive data visualization and mapping application. Use it to create visualizations easily and rapidly from simple Flash maps to advanced infographics. Stat Planet is a free application for creating thematic maps and graphs with the click of a button. It enables you to explore science, technology, innovation, demographic, education, environment, health and socio-economic indicators from various sources such as UIS and UN Data Division, World Bank, etc. It is also possible to produce customized interactive maps and graphs by adding or importing specific data. Stat Planet can be used either online or as a stand-alone desktop application.

The aim of Stat Planet is to promote evidence-based decision-making by improving and facilitating the communication and interpretation of information. Stat Planet does this by providing (i) attractive interactive visualizations which facilitate the interpretation of information, (ii) a user-friendly interface that is accessible also to non-technical users, (iii) automated data visualization (including the processes of merging and synchronizing data from different sources) and (iv) an easy to disseminate software system which can enable anyone to explore and create data visualizations - regardless of technical skills, availability of Internet connectivity and computer hardware or software.


**Figure 4: A layout of SPIN´ Stat Planet software. The graph shows the distribution of full-time equivalent (FTE) scientific researchers (in thousands) within the Latin America and Caribbean countries.**

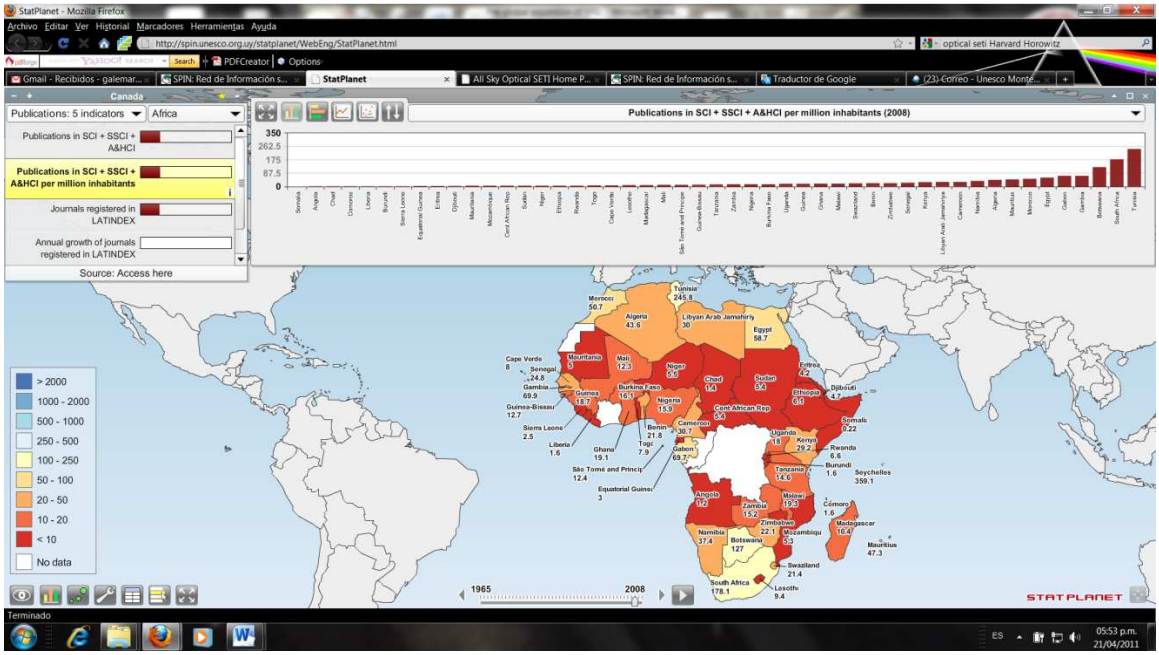



**Figure 5: Distribution of scientific publications in the Science Citation Index per million people in Africa.**

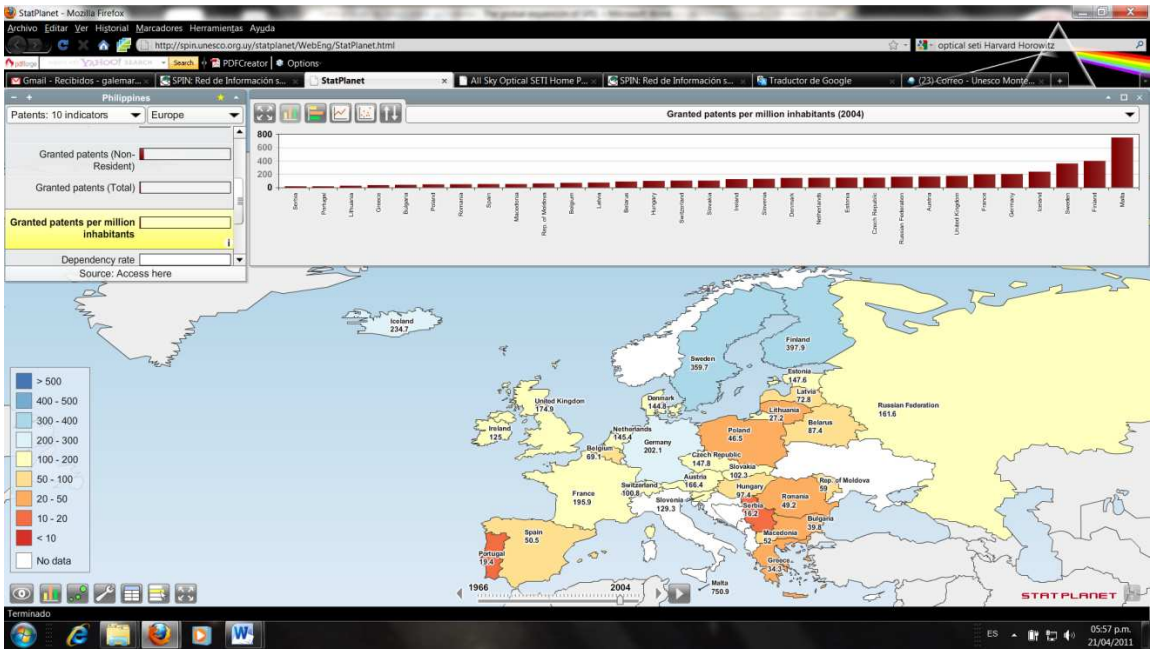



**Figure 6: Distribution of patents per million people in Europe.**

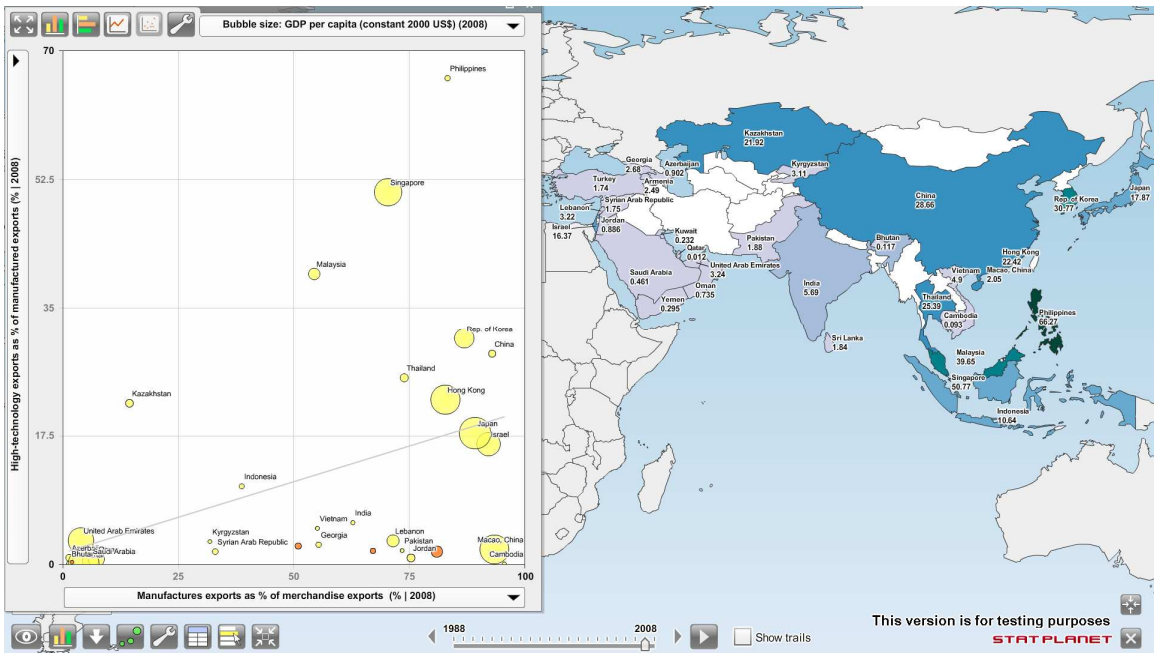



**Figure 7: Cross correlation among different indicators in Asia.**

Stat Planet was conceptualized by Frank van Cappelle and has been developed by him since 2005. From 2008 to 2010, the development of a tailored version of Stat Planet was undertaken as part of the SACMEQ research programme at the UNESCO International Institute for Educational Planning (IIEP). During 2010, the SC PSD programme at the Regional Bureau for Science in Latin America and the Caribbean contacted Mr van Cappelle at UNESCO IIEP and customized the Stat Planet software to use it as part of SPIN.

Stat Planet has different ways for representing national and regional data in different types of graphs and also for estimating the evolving "trajectories" of each indicator in time, which constitute a valuable tool for any STI decision-maker. It also has the possibility for making cross correlations among different time series up to four different dimensions. For example, in Figure 7 we represent in the horizontal axis the ratio between manufacture exports over total exports (2008), in the vertical axis the ratio between high-tech exports over manufacture exports (2008), while the size of the bubbles represent the GDP per capita in constant US Dollars for the year 2000, in this case, for all the Asian countries. This type of graph can also show the time evolution of all these indicators.

The Stat Planet module at global level will be operational and available on-line by the end of 2011.

The SPIN platform includes two others databases. The first one contains an inventory of 170 national and international organizations and other NGOs which provide technical and financial co-operation in science and technology. These institutions are classified by *Co-operation Area* (social sciences, engineering and technology, agricultural sciences, medical sciences, exact and natural sciences, humanities); by *Type of Co-operation* (technical, financial); by *Geographical Focus* (Global; Latin America and the Caribbean; Asia; Africa; Center, North and South America; Europe; Asia Pacific; Middle East) and by *Type of Beneficiary* (governments, institutions, individuals, enterprises).

SPIN also has a digital library specializing in STI with more than 800 titles published by UNESCO which are classified by themes (15) and collections (6). It is also possible to search for a specific publication by title, author, or keyword.

SPIN has a country (or regional) profiler tool which combines the description of each STI system, legal framework, inventory of policy instruments, list of publications about the country available at the digital library, links to recent governmental reports and other relevant documents on STI policies, a series of links to official sites on STI policies for each country and other external databases on STI indicators, links to National Academy of Sciences and access to the LATINDEX portal. Finally, it also has an exploration tool, based on a keyword search, which allows finding any specific information among the different SPIN databases.

At this point it should be stressed that the GO→SPIN platform is intended to provide a coherent tool for decision-makers, academics and experts, to analyse the impact of STI policy-making best practices and their policy instruments, as well as to understand the long-term evolution STI policy-making organizations, infrastructure and STI production.

## 5. Other initiatives

During the last fifty years, several international organizations such as UNESCO, OECD, UNCTAD, UN ECLAC, OAS, OEI, IDRC, IADB, WB, as well as other research and academic institutions like NSF, NRC, SPRU, UNU-MERIT, IEC-UNQui or Centro REDES-RICYT have been analysing STI policies and policy instruments that were implemented at different parts of the world.

The first systematic database built on STI policy instruments was published during the seventies, as part of the IDRC-STPI Project. Besides the fact that this database is completely out-of-date, it is still very useful from a conceptual point of view. It is possible to have a complete access to this database by downloading a *pdf* file from:

http://idl-bnc.idrc.ca/dspace/bitstream/10625/4293/1/31780.pdf.

During the last five years, several initiatives emerged around the world. Probably, the most comprehensive one is ERAWATCH (http://erawatch.jcr.ec.europa.eu/), which is the European Commission's information platform on European, national and regional research systems and policies. Its main objectives are to support policy-making in the research field in Europe and to contribute to the realisation of the European Research Area (ERA). By August 2011, the service covered 49 countries: 27 EU Member States, countries associated with the European Community's Research Framework Programme and, for comparative purposes, main trading partners of the EU. The site is organised as follows: (1) National profiles, including national and regional information, (2) European perspective, comprising European level information and (3) Reports, section, devoted to analysis on research policy issues, country overviews and trends. ERAWATCH is targeted at all those involved in research policy-making in Europe.

ERAWATCH website is currently undergoing a thorough update, with coverage extended to 64 countries: 27 EU Member States, 13 countries associated with the European Community's Research Framework Programme and 24 third countries.

In 2008, with the sponsorship of GTZ, UN ECLAC set-up an interesting prototype of STI policies database (http://www.eclac.org/iyd/). The system was designed by Cimoli and Primi (2008) and includes 42 countries.

In 2008, the IADB and RICYT (Lemarchand, 2008) developed another database on STI policy instruments for 14 LAC countries. It is accessible at http://www.politicascti.net/. In order to keep a normalization criteria, the twelve descriptors proposed here to analyse each operational policy instrument, are the same as those used by UN-ECLAC.

Unfortunately, the last two databases were unable to provide a detailed inventory of each individual STI policy instrument. For example, they list several scientific and technological funds without listing all the policy instruments that each fund is currently managing. In this way, it is not possible to analyse in depth the complete set of explicit STI policies applied on a specific country. Another disadvantage of the last two platforms is that they do not present any “legal framework” inventory and their inventories of STI national systems have not been updated at regular bases. The combination of the countries analysed by UN-ECLAC and IADB-RICYT databases represents a small subset of the countries surveyed by the combination of ERAWATCH and SPIN.

In order to compare the different initiatives, Figure 8 shows the main characteristics of each database. ERAWATCH covers developed nations and the GO→SPIN developing countries. The combination of both platforms might combine, by the end of 2011, a complete survey of more than 100 different countries, with an inventory of more than 1,200 STI operational instruments, almost 2,000 documents and a set of 450 time series of indicators for all the countries in the world.

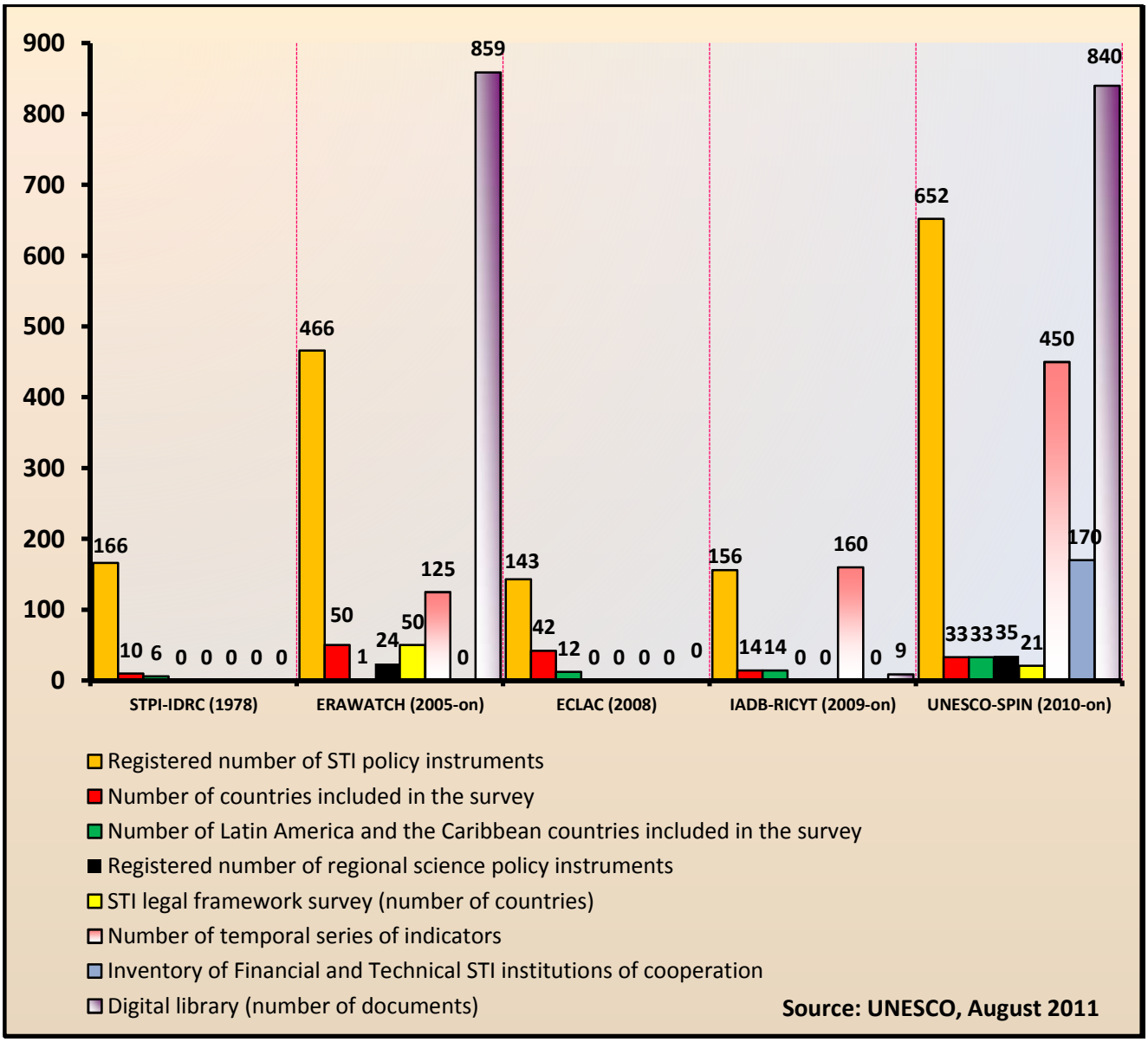



**Figure 8: Characteristics of different databases on STI Policy Instruments**

**Table 2: Geographical coverage of different platforms (September 2011)**

| UNESCO Regions[8] | Total Countries | ECLAC | IADB-RICYT | ERAWATCH | SPIN |
|---|---|---|---|---|---|
| Africa | 54 | 1 | — | 5* | 6** |
| Arab States | 21 | — | — | 5 | — |
| Asia and the Pacific | 50 | 10 | — | 7 | — |
| Europe and North America | 53 | 18 | — | 43 | — |
| Latin America and the Caribbean | 34 | 12 | 14 | 4 | 33 |

*From this list 4 countries also appear within the Arab States list; **Pilot countries (2011) not included at the ERAWATCH survey.

Table 2 shows the geographical distribution of countries among UNESCO regions[8] surveyed by the different platforms. Only four LAC countries are overlapped between ERAWATCH and SPIN. A strategic alliance to share experiences and surveys, between the last two platforms can generate information on STI policies for almost 100 countries in a short period of time. It is imperative to develop common standards on how to present the information on STI policy instruments. This might be done following the standards that will be proposed by the "Paris Manual" (see § 6).

For evaluating the performance of the STI policies and for making *technology intelligence studies* (TIS) it is possible to have access to a large group of public and private databases. There are robust and accessible systems that are designed to make rapid analyses, applied mathematical models to identify critical points or levers that policy changes can directly affect the performance of innovation activities. Zucker and Darby (2011) present a comprehensive survey of all the available databases that might be used to analyse the impact of STI policies. Special modules with data access from these databases in combination with new customized software tools might also increase the analytic capabilities of GO→SPIN.

## 6. The "Paris Manual": Standardization of Information about Science, Technology and Innovation Policy Instruments

UNESCO will convene a group of international experts to set-up the guidelines for the normalization and standardization of all the information related to science, technology and innovation policies and their respective STI policy instruments. These procedures should include accurate descriptions related to the selection of relevant variables, categorization schemes, alternative procedures to make national STI policy surveys, descriptors for STI policy instruments and any other relevant measurements related to STI policies.

The "Paris Manual" should provide the necessary guidelines to make the different existing STI policy platforms more compatible and comparable. The Manual should also

[8] Here we applied the distribution of Member States per region approved by the 32nd General Conference of UNESCO (32 C/21 of 19 September 2003). Under this classification there are countries which are included simultaneously at two different UNESCO regions.

provide Member States a collection of recommendations for the organization and publication of all the information on their national STI policies. This will favour the comparability of STI policy instruments and STI policies across different countries.

The Manual should also provide guidelines to identify *explicit* and *implicit* STI policy instruments as well as other industrial, educational, financial, social or general policies that may have an indirect impact on the behaviour of STI activities.

The Manual should also provide a template to organize all the national (or regional) STI policy analysis as well as suggest recommendations for Member States on how to publish the information on their national STI policies, STI policy instruments and any incentives for STI activities on their websites.

The Manual should propose some guidelines to analyse STI policy instruments among the high-tech multinational, big, medium and small firms.

The suggestions provided by the "Paris Manual" will define how the architecture of the GO→SPIN platform will be finally organized.

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