

THE SCIENCE AND TECHNOLOGY PROFILE OF THE LEBANESE REPUBLIC



Evaluation of Science, Technology and Innovation
capabilities in Mediterranean countries
Evaluation des Capacités Scientifiques Techniques
et d'Innovation des Pays Méditerranéens

LEBANON

Evaluation of Scientific, Technology and Innovation Capabilities in Lebanon

Jacques Gaillard

Senior researcher at the Institut de Recherche pour le Développement (IRD)

in collaboration with

Jacques Kabbanji, Joseph Bechara and Mona Assaf

Co-ordinator: Rigas Arvanitis

About the principal author:

Former deputy and acting director of the International Foundation for Science (IFS) in Stockholm, Sweden, and former director of the Office of Policy and Coordination of the Department of Technical Cooperation at the International Atomic Energy Agency (IAEA), Jacques Gaillard is now a senior researcher at the Institut de Recherche pour le Développement (IRD) in Paris, France.

A trained agricultural engineer with a PhD in Science, Technology and Society (STS), his main areas of interest and expertise are science, technology & innovation policies and indicators, evaluation and impact studies; comparative analysis of international S&T cooperation policies for sustainable development and environment; international S&T migration. He has published more than 50 articles in peer-reviewed journals on S&T policies, the sociology of S&T, scientometrics, evaluation and impact studies, etc.; presented more than 50 papers in scientific meetings, and written close to 40 chapters for books. He has edited 14 conference proceedings and books and written 5 books. The most recently published books are: *Scientific Communities in the Developing World*, 1997. New Delhi: SAGE India (in collaboration with V.V. Krishna & R. Waast); *La coopération scientifique et technique avec les Pays du Sud. Peut-on partager la science ?* 1999. Paris: Karthala, collection "Hommes et Sociétés"; *Les enjeux des migrations scientifiques internationales. De la quête du savoir à la circulation des compétences*. 1999. Paris: L'Harmattan (in collaboration with A-M Gaillard).

The following reports were prepared and used in the framework of this study:

CNRS (Mouïin Hamzé and Mona Assaf). 2007. Scientific Research Capabilities in Lebanon. 213 pages.

Kabbanji J. 2007. Contribution à l'étude des capacités scientifiques dans les sciences sociales et exactes et l'innovation au Liban : aperçu historique, 20 pages.

Kabbanji J. 2007. Rapport sur l'état de la recherche en sciences sociales au Liban, 14 pages + 43 interviews.

Bechara J. 2007. Rapport sur l'état des sciences exactes au Liban, 20 pages + 27 interviews.

Kabbanji J. 2007. L'innovation au Liban (structures et institutions): apports et limites, 23 pages.

Part 4: Lebanon publications outputs:

OST (Françoise Laville et Jean Thèves). 2007. Country Leaflet – Lebanon, 30 pages.

IRD (Rossi Pier Luigi): PASCAL/INIST data computing.

1. Introduction

This evaluation of scientific, technology and innovation capabilities in Lebanon is part of a larger regional project called ESTIME (Evaluation of Science, Technology and Innovation capabilities in Mediterranean countries) involving eight of Europe's Mediterranean Partner (MP) countries: Morocco, Tunisia, Algeria, Egypt, Lebanon, Syria, Jordan, and Palestinian Territories.

The objective of the ESTIME project is to propose a set of strategic policy instruments aiming to establish a dynamic view of the research and innovation systems in Mediterranean Countries and to contribute to a better understanding of the ways institutions operate in the MP countries. This project, hopefully, will contribute to promoting and strengthening S&T cooperation between the Mediterranean and the European countries by identifying the most active research institutions and laboratories, the conditions for their development, the strengths and weaknesses of their systems and their most pressing needs and, above all, by establishing a common language for the strategic evaluation of S&T capabilities among partners. Such objectives are already considered as important by the *Institut de Recherche pour le Développement* (IRD) which contribute to the project by seconding some IRD researchers.

ESTIME is being developed in close partnership with a team of European and local partners. In Lebanon, the National Council for Scientific Research (NCSR or CNRS in French) was in charge of gathering information on the national scientific research capabilities, a task it assigned to Ms Mona Assaf, head of international relations and cooperation at NCSR. Jacques Kabbanji, Professor of Sociology at the Lebanese University (UL), coordinated two specific surveys (social sciences and exact sciences) and a study on innovation in Lebanon while Joseph Bechara, Professor of Physics at the UL, conducted the survey on exact sciences. This report takes stock of the information submitted by the Lebanese partners. In April 2007 Jacques Gaillard (IRD research scientist) visited the main S&T institutions, collected missing information and made additional interviews to round out the report.

In Lebanon, the scarcity and inadequacy of statistics is patent and widely recognised. This is true in all areas but particularly in science, technology and innovation (STI) for which indicators are non-existent. As correctly stated in the STIP report (CNRS, 2006), STI indicators are not only used in international comparisons, but are essential to guide policy-makers in developing and targeting new policies, to provide a certain standard of performance and to build up a sense of accountability. Without a coherent statistical system, data collection and the construction of reliable STI indicators becomes a titanic task.

The study was carried out during a period of major turmoil in Lebanon. Although the ceasefire of the 2006 war went into effect in August 2006, the domestic socio-political situation remained very tense throughout the time of the study. Lebanon is a small but very complex country. This also characterises the country's Scientific, Technological and Innovation (STI) system, which includes the higher education institutions. Since the Lebanese system is a product of the country's political, religious, cultural and economic history, we are starting this report with a short country profile that puts the STI survey into context.

2. Country profile

Lebanon is a small, (10,452 sq km, 4,036 sq mi) mountainous country in the Middle East, located at the eastern edge of the Mediterranean Sea. Between the Lebanon and Ante-Lebanon mountains lies the Bekaa valley, the principal agricultural area. Lebanon is bordered on land by Syria to the north and east, and Israel to the south. Lebanon's population was estimated at nearly 4 million in July 2007¹ (Wikipedia, the free encyclopaedia), with about 2 million living in and around Beirut, the capital. The country has limited natural resources, (limestone, iron ore and salt) except for water. Rainfall, surface water resources and groundwater reserves largely contribute to Lebanon's abundant water surplus.

Lebanon is the historic home of the Phoenicians, Semitic traders whose maritime culture flourished there for more than 2,000 years (c.2700-450 B.C.). It is a centre for many nations and cultures, skilled in trade and in art. The region was a territory of the Roman Empire, during the Middle Ages it was involved in the Crusades and, thereafter, was taken over by the Ottoman Empire. The mountainous territory of Mont Lebanon has long been a shelter for minorities and persecuted peoples such as the Maronite Christians, the Druze, and other groups. During the nineteenth century, the town of Beirut became the most important port of the Middle East as Lebanon became a centre of silk production for export to Europe. This industry made the region wealthy, but also dependent on ties to Europe.

The country was granted full independence in January 1944. Following independence, Lebanon's history has been marked by alternating periods of political stability and turmoil interspersed with prosperity built on Beirut's position as a regional centre for finance and trade. In the 1970s difficulties arose over the presence of Palestinian refugees, many of whom arrived after 1967. A full-scale internal-cum- regional civil war that broke out in April 1975 lasted for over 16 years, with intervention by the neighbouring countries. Years of heavy fighting resulted in a ruined economy, violence, a high death toll, destruction of Beirut and other devastating effects. In October 1989 a "National Reconciliation Accord" – that marked the beginning of the end of the war – was concluded in Taif, Saudi Arabia at a meeting of the Lebanese National Assembly. By 1991, Lebanon had made progress toward rebuilding its political institutions and regaining its national sovereignty. Lebanon's economic growth was doing well until the 2006 war (July 12 to 14 August), which caused large numbers of civilian and military casualties, extensive damage to civilian infrastructure and massive population displacement. In September 2006, the Lebanese government launched an early recovery plan to reconstruct bridges and property destroyed by Israeli attacks, mainly in Beirut, Tyre, and villages in southern Lebanon. However, since the end of 2006, the domestic political situation has been tense, the Parliament is closed, and the "confessional democracy" is blocked, with no realistic hope for an early solution.

Lebanon is a parliamentary republic with a multireligious and multiparty government. It has a National Pact, an unwritten covenant, that provides for a Maronite Christian president, a Shi'it Muslim Speaker of Parliament and a Sunni Muslim prime minister. This unwritten covenant also has a strong effect on the distribution and balance of high-ranking positions in government, public administration and also within the Lebanese University, the only public university in Lebanon.

¹ The fact that no official census has been made since 1932 shows Lebanon's political sensitivity about confessional (i.e. religious) balance.

3. The Lebanese Science and Technology base

Lebanon has a small but diverse and dispersed S&T community embedded in 41 universities and higher education institutions (12 of them with science and/or technology faculties) and 6 rather small research centres. All indicators (publication output, research budget, number of active researchers ...etc), show that most of the research is carried out in three universities: the Université Libanaise or Lebanese University (UL), the Université St-Joseph or St-Joseph University (USJ) and the American University of Beirut (AUB), sometimes in collaboration with one of the four specialised research centres of the National Council for Scientific Research (NCSR) and/or the Lebanese Agricultural Research Institute (LARI).

Given the small size of most manufacturing companies in Lebanon² private sector R&D is still very limited. Hopefully, initiatives such as the creation of the Lebanese Industrial Research Association (LIRA) in 1997 and the promotion of joint industry-university research projects will increase private sector contributions and participation. There is also an increasing number of private research institutes, often NGOs, that carry out studies, mainly socio-economic studies such as opinion polls, market studies, and studies for international organisations e.g. the UN system. They very frequently use the services of university staff, mainly from the UL.

Due to the paucity of reliable statistical information on human resources and research budgets and the lack of a central institutional mechanism to collect this information, we had to spend many hours contacting each institution individually to gather whatever information was available. Despite our efforts there are still inconsistencies and gaps that need to be filled. The information and data presented below need to be refined and improved but at this stage already constitute one of the very first attempts³ to systematically evaluate S&T capacities in Lebanon using internationally recognised indicators.

3.1 *Brief historical background*

The origin of modern higher education in Lebanon can be traced back to the second half of the 19th Century and linked to the proselytism of different religious groups. The American University of Beirut (AUB), originally called the Syrian Protestant College (SPC), was the first one, it was to be established (1863) by American protestant missionaries in Lebanon and Syria. The SPC started its first class, composed of 16 students, on December 3, 1866. Since the earliest years, it has continually expanded and developed new faculties and programmes. In 1867, its school of medicine was started. Four years later, a school of pharmacy and a preparatory school were added. In 1900, the SPC established a school of commerce that was later incorporated into its Faculty of Arts and Sciences. When the university hospital (currently the American University Hospital) opened in 1905, SPC established a school of nursing and in 1910, a school of dentistry. On November 18, 1920, the Board of Regents of the State University of New York changed the name of the institution from the Syrian Protestant College to the American University of Beirut. The early 1950s was a period of rapid expansion: the Faculty of Engineering and Architecture was established in 1951; the Faculty of Agriculture, now the Faculty of Agricultural and Food Sciences, in 1952, and, finally, the School of Public Health - now the Faculty of Health Sciences - was started in 1954.

The Université Saint-Joseph (USJ) followed soon after the Syrian Protestant College as a fearsome competitor. Founded in Beirut in 1875 by Catholic Jesuits, USJ started by creating a Faculty of Theology, as the "heir" to the Ghazir School of Theology, based in north Beirut, where the catholic clergy, mainly Maronite priests, had been trained. The USJ Faculty of Medicine was opened in 1883, and grew to include a department of pharmacy in 1889, dentistry in 1920, and a school of nursing in 1922. An engineering school called the "*École française de génie*" was established in 1913, the same year as a Faculty of Law, with assistance from the University of Lyon in France. The Faculty of Economics followed soon after.

² Approximately 75% of Lebanese manufacturing companies have fewer than five workers and the top 41 production units employ more than 250 workers (Figuié, 2005).

³ To the best of our knowledge, the last statistics publicly available on the Lebanese S&T community were collected by UNESCO in 1980 and only refer to the Faculty of Science at the Lebanese University.

Although two more universities were created (Université La Sagesse in 1875⁴ and the Lebanese American University in 1924), AUB and USJ completely dominated the higher education scene in their respective fields up to the 1950s. Law courses and training for senior civil servants remained the prerogative of USJ, which, until recently, was the preferred school of future presidents, deputies, members of parliament and judges. AUB gave priority to medical and related sciences as well as applied sciences. Economics was recognised as a discipline in the early 1930s, but only at AUB. This situation changed with the creation of the Lebanese University (UL) in 1953 as an attempt to democratise higher education in Lebanon. UL is an extension of the *École Normale Supérieure*. As the first and only public university in Lebanon, it soon attracted students from the middle and popular classes of the Lebanese society, and increasingly focused on social and exact sciences. The UL is now composed of 15 faculties and 3 institutions, broken down into 47 sections that cover the whole country. Close to 50% of the country's higher education students attend this university.

National research institutes are more recent. Although formally established in 1975, the roots of the National Centre for Geophysical Research (NCGR) go back to 1920 to the Ksara Observatory (1920-1978) run by the Jesuit Fathers as the only observatory of its kind in the Eastern Mediterranean for many years. Agricultural research in Lebanon dates back to the establishment of Tal Amara station in the Bekaa Valley immediately after independence (1946) as an agricultural training centre, supported by French technical assistance. A few other research institutes were created in the 1970s, 1980s, and 1990s.

For understandable reasons, the civil war of the 1970s and 1980s and the more recent 2006 conflict delayed or stopped many S&T initiatives and programmes to which government was no longer anxious to grant high priority or commitment. Universities, however were not closed down during the war years; most research was carried out at the AUB and UL, although some programmes had to be relocated. Research was also continued in the research institutes although some research laboratories/centres were closed or relocated, e.g. the Centre for Marine Research located in Batroun, 50 km north of Beirut, was closed and temporary laboratories were installed in Jounieh, much closer to Beirut. Today, both locations are used by the Centre for Marine Sciences (CMS), one of the four research centres of the National Council for Scientific Research (CNRS).

3.2 *The S&T Policy Framework*

There is no ministry in charge of the national S&T policy-making in Lebanon. But, in 1962, the Government recognised the increased role of S&T in the country's socio-economic development by creating the National Council for Scientific Research (CNRS), a public agency with administrative and financial autonomy under the authority of the Prime Minister. The CNRS has three major functions:

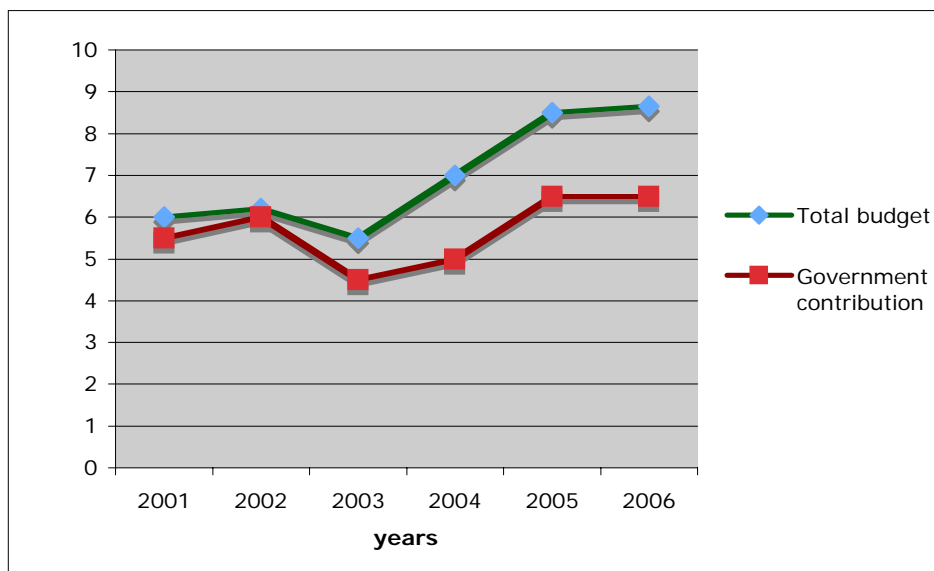
1. An advisory function. The CNRS draws up the general outline of Lebanon's National Science Policy designed to develop research and optimise the use of Lebanon's scientific resources for development purposes. It advises the government on all issues related to science and national science policy. It also carries out surveys and inventories of on-going research activities in private and public institutions throughout the country.
2. A programmatic and implementation function. This function mainly involves the implementation of the National Science Policy, wherefore the CNRS initiates, encourages and coordinates research activities. As part of this function, the CNRS runs several calls for proposal addressed to the overall Lebanese scientific community. It also runs and organises scientific research activities within its work programmes and formulates work programmes in cooperation with the appropriate ministries and the private sector.
3. A research production function. The CNRS manages and runs four research centres: 1) the Centre for Geophysics, 2) the Centre for Marine Sciences, 3) the Centre for Remote Sensing, and 4) the Lebanese Atomic Energy Commission (LAEC).

4

Founded in 1875 by the Maronites in Beirut, the law school Al-Hikmat (La Sagesse - Wisdom) was closed in 1913, following the creation of the Faculty of Law of Saint-Joseph University. The school was re-established in 1961 as a higher education institution for studying law. It became a multidisciplinary university in 1999.

The main part of the CNRS budget comes from the Lebanese government (see Figure 1). Over the last six years, the government contribution fluctuated between a low 4.5 billion LBP in 2003 and a high 6.5 LBP in 2005 and 2006. The total budget in 2006 was 8.650 billion LBP or 5.766 million US\$⁵. The difference between the total budget and the government contribution mainly comes from the university's accumulated reserve fund⁶.

Figure 1: Evolution of the CNRS budget in billions of LBP (2001-2006)



The CNRS is governed by a Board of Administration and managed by a General Secretariat. The Board of Administration of the CNRS is the decision-making authority. Board members are appointed by the Council of Ministers upon the recommendation of the Prime Minister. Members of the Board of Administration reflect a broad spectrum of eminent scientists who are appointed for a renewable six-year term. One third of the Board members rotate on a biannual basis following their initial appointment. Professor Georges Tohmé, appointed President of the Board of Administration in 1993, chairs the CNRS. The General Secretariat prepares and implements annual programmes submitted to and approved by the Board of Administration of the CNRS. In 1998, Professor Mouin Hamzé was appointed Secretary General by the Council of Ministers.

In addition to managing its four research institutes, the CNRS runs the following integrated action programmes addressed to the Lebanese scientific community as a whole:

- The Science, Technology and Innovation Policy Programme,
- The Research Grant Programme (RGP),
- The PhD Fellowship Programme,
- The Science and Technology Culture Programme,
- The CNRS Associated Research Units (URA).

⁵ 1 US\$=1500 LBP.

⁶ The remaining reserve at the end of 2006 was only 2.832 billion LBP.

Since 2000 the CNRS has been publishing the semi-annual Lebanese Science Journal (LSJ)⁷ and is managing a number of bilateral and multilateral scientific cooperative agreements and funding programmes.

3.2.1 The Science Technology and Innovation Policy Programme

Over the past several years the CNRS has increased its efforts to initiate a new national policy for science, technology and innovation. In April 2001, Dr. Peter Tindemans, an external consultant, presented a report, to the CNRS and UNESCO as a plan of action for the preparation of a Lebanese Science, Technology & Innovation Policy (STIP) that is fully integrated with overall economic and social policies. His report was based on the available documentation and numerous discussions with relevant stakeholders in Lebanon during February 2001. The plan of action for the STIP proposal was approved in late 2002.

Responsibility for preparing the STIP was entrusted to a group of some 30 Lebanese experts from the universities, the CNRS, and (a few) the private sector and industry. During the first half of 2003, these experts, divided into three task forces (Basic Sciences, Industry and Engineering; Environment, Agriculture and Biological Sciences; and Health and Medical Sciences), prepared and presented their final reports. The main findings were presented in a report published by CNRS in 2006 (CNRS, 2006).

The three task forces worked independently but closely with Dr. Peter Tindemans and the CNRS, which assured the overall coordination and logistical support. The final STIP plan was financed by UNESCO and ALECSO and drew heavily on the task forces' reports. Substantial technical input has also been provided by UN-ESCWA.

Each task force identified, prioritised and selected a number of societal needs and ambitions. The justification for their selection can be traced to Lebanon's economic, social and environmental challenges and opportunities, and the legitimacy for these choices can be found in government policy documents, economic priorities, international protocols, etc. Each societal need was translated into carefully selected activities in research, education, training and research system reinforcement, including activities in the area of technology dissemination, transfer, and innovation. To achieve these results with due respect for the Lebanese particularities and maximum agreement among the experts, several commonly used techniques such as SWOT⁸ analysis and QFD⁹ have been applied. Many of the observations and findings about the present situation of Lebanese higher education and research are derived, for example, from the SWOT-analyses made by the task forces.

3.2.1.1 Objective and Stakeholders

The objective of the STIP Plan is to increase and focus national efforts in science, technology and innovation, with the aim of strengthening the STI institutions and gearing them towards the creation of high-quality jobs, hence economic growth and improvement of the quality of life, as well as towards strengthening the position of Lebanon as a regional centre for high-quality education and research, economic development, trade, tourism and health care. The Plan identifies a number of specific opportunities in three areas: 1) basic science, industry (including services) and engineering, 2) environment and agriculture, and 3) medicine and health care.

The STIP Plan also aims at strengthening partnerships between universities, the CNRS and research institutes on the one hand, and between those organisations and private enterprise, other private organisations, and public agencies on the other. Another aim is to strengthen Lebanon's participation in regional and wider international networks in science, technology and innovation, and to use those networks for the most effective and efficient implementation of the Plan.

⁷ Prior to the publication of the Lebanese Science Journal (LSJ), the CNRS published The Lebanese Science Bulletin (1985-1990 and 1992-1998).

⁸ Strengths, Weaknesses, Opportunities, Threats

⁹ Quality Function Deployment

According to the STIP Plan, all actors in the field of science and technology, including the CNRS, universities, research institutes and individual scientists should commit themselves to the Plan's goals and implementation. Respectful of each actor's independence, the Plan constitutes a challenge and an invitation to address the opportunities for Lebanon to become a knowledge-based society, and the obstacles to achieving this objective.

The private sector, including business community, and the government together with other public sector actors are key players in fine-tuning the Plan's targets and must be actively involved in its implementation. The government has an especially critical role in creating the necessary conditions, particularly financial and regulatory conditions, to accomplish the economic and social potential implied in the activities of the Plan. However, while financial means are important, they are not everything.

The Plan was prepared under the auspices of CNRS, with input from many specialists from universities and other national organisations. It is a road map for Lebanon as a whole, and addresses a number of major country-specific problems and needs. The CNRS must work together with the leading national universities and institutes to ensure its successful execution.

3.2.1.2 Societal needs as the basis for Lebanon's STI policy for 2006-2010

The STI Plan develops activities and policies in three domains that are strongly linked to fields of science that are especially important for the Lebanese economy.

The **first domain** concerns **industry**, including the related development-oriented **service sector, basic sciences and engineering**. Based on the assumption that industry should be the key driving force of economic development, the Lebanese science and technology organisations and workers are requested to focus specifically on its needs and define the appropriate underlying research, human resources and dissemination activities. The aim is to address seven societal needs, which are based on regional and national studies:

1. Improve the management of energy, water, and other natural resources by adopting an integrated and sustainable approach;
2. Reduce industrial operating cost (energy, equipment, and maintenance);
3. Harness information and communication technologies for development;
4. Harness and strengthen scientific research for development;
5. Improve productivity in industry, increase technology and information content;
6. Establish new suitable industries for development and job creation;
7. Increase share in international trade and export performance.

Since the environmental concerns and challenges for Lebanon are huge, the environment is the umbrella for the second domain. But considering the economic, social and environmental pre-eminence of agriculture in Lebanon, and its links with often-constraining environmental conditions, concerns and measures, the **second domain will be spanned by a combination of environment and agriculture**. One challenge here will be to identify common activities, based on broad commonalities in the underlying science base and related opportunities. The aim is to address four societal needs, which reflect Lebanon's national policies and international obligations:

1. Stabilisation (and/or prevention) of coastal deterioration through sustainable management;
2. Integrated water management for an effective supply/demand balance;
3. Grasping new agricultural economic opportunities;
4. Improved nutritional food quality.

For any country and, in a regional context even more so for Lebanon, the **health care and medical domain** will become increasingly important in the future. Over the past decades this domain has essentially been dominated by science and technology. The ambition in this domain is to address the following societal needs:

1. Resume the position of Lebanon as a regional leader in the field of medicine and health care by improving higher medical and health science education, as well as the quality and cost-effectiveness of medical and health care services;
2. Create an environment conducive to a flourishing biomedical industry and services sector.

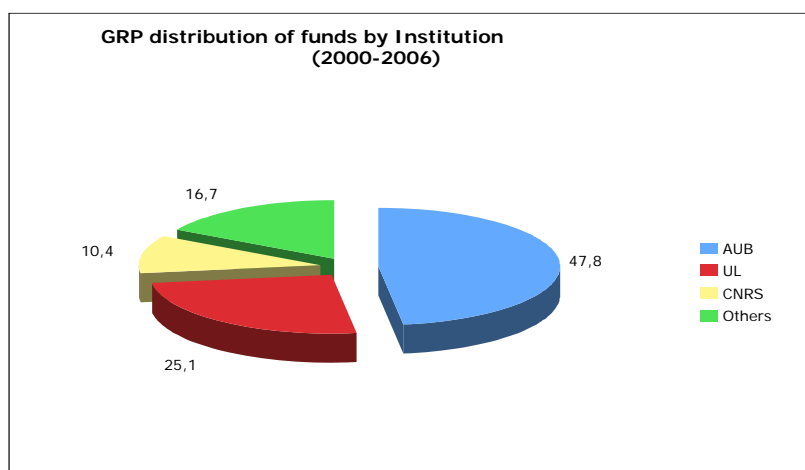
Each of these domains offers many opportunities for the fulfilment of vital societal needs through the implementation of science, technology and innovation. Since not all of these societal needs can be addressed at the same time, a selection has been made of the most suitable and urgent needs. Detailed activities and justifications are provided in the full report (CNRS, 2006).

3.2.2 The Grant Research Programme (GRP)

The Grant Research Programme (GRP) is a CNRS tool for sponsoring research projects implemented in public and private universities, and in national or private research institutions including the CNRS affiliated research centres. Since 2000, one or two calls for applications have been launched every year. Applications from all scientific disciplines were accepted, except for the social and behavioural sciences that were not eligible in 2001 and 2002. Task forces, organised by research area, evaluate all research proposal submissions, and the CNRS Board decides which projects to fund.

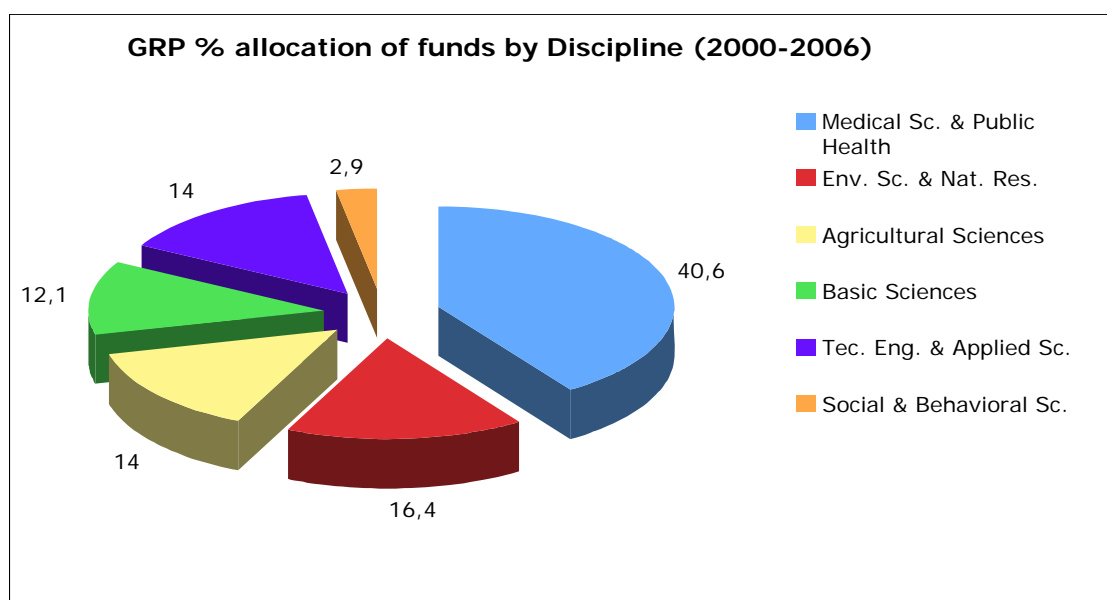
Over the last seven years (2000-2006), 614 projects have been approved for a total budget of US\$3,274,050 or an average of US\$5,332 per project. On average, and according to statistics for the last four years, half the projects submitted (48,5%) have been approved. According to international standards, this is a rather soft selection rate. The CNRS had the best "success" rate (70.4%), followed by AUB (57.9%); four other universities (USJ, LAU, UL, USEK) scored slightly lower (between 47.6% and 45.0%). As clearly shown in Figure 2, the project distribution was highly concentrated in three institutions: AUB, UL and CNRS (82.1% of the projects and 83.3% of the funds). Among the three, AUB was, by far, the top recipient (42.3% of the projects and 47.8% of the funds), followed by the UL (30.5% of the projects and 25.1% of the funds) and CNRS (9.3% of the projects and 10.4% of the funds). Other recipient institutions, included universities (e.g. USJ, USEK, BAU, Balamand, LAU) and the Lebanese Agricultural Research Institute (LARI).

Figure 2: Distribution (%) of GRP funds by institution (2000-2006)



Surprisingly, given its research capacities and facilities, the Université Saint-Joseph (USJ) submitted very few proposals to the Grant Research Programme. During interviews USJ confirmed its limited interest. USJ scientists tend to prefer applying to the USJ research fund and/or to bilateral and international funding programmes. Another question concerned the relatively low number of applications submitted by UL scientists and their significantly lower success rate, compared to AUB or CNRS scientists. As discussed in more detail below, UL is by far the biggest university in Lebanon with a research potential, expressed in number of PhD staff, at least 5 times bigger than that of AUB.

Figure 3: Distribution (%) of GRP funds by discipline (2000-2006)



Given that AUB, the top recipient institution, is highly specialised in Medical Sciences and Public Health, the latter research area is, with 40.6% of the funds allocated and 34.2% of the projects approved, the top recipient area (see Figure 3). It is followed by a group of four research areas receiving between 12% and 16% of the funds allocated: Environmental Sciences & Natural Resources (16.4%), Agricultural Sciences (14.0%), Technical, Engineering & Applied Sciences (14.0%) and Basic Sciences (12.1%). At the far end, Social & Behavioral Sciences were only granted 2.9% of the funds allocated for 4.7% of the projects.

3.2.3 *The PhD Fellowship Programme*

The CNRS has been one of the major public sources of fellowships for Lebanese PhD candidates specialising in scientific disciplines, either abroad or in Lebanon. The PhD Fellowship Programme was started in 1963. Over 450 PhD holders, who benefited from this programme between 1963 and 1983, now work in Lebanese universities. Similarly, most of the senior staff of the CNRS are past recipients of these fellowships. Due to economic constraints, this programme was frozen in 1983 and was reactivated as of the 1999-2000 academic year. Since that date, the CNRS has also been granting fellowships to students from foreign universities who do their research at the Lebanese University and/or in a CNRS research centre.

At the end of the 2001-2002 academic year, the CNRS introduced the undergraduate programme called "Scholarships for Excellence" designed to reward and encourage students ranking first in the baccalaureate exams (all categories). It grants these outstanding students a university scholarship. Up to now, 27 students have benefited from this programme.

During the last eight years (1999-2006), US\$3,375,000 have been spent on the PhD Fellowships and the Scholarships for Excellence Programmes. Since 1999, scholarships have been awarded to 135 PhD fellows. The breakdown: 97 went to France, 21 stayed in Lebanon, 7 went to England, 3 to Canada, 3 to the USA, 2 to Belgium, 1 to Germany and 1 to Greece.

3.2.4 *The Science and Technology Culture Programme*

The Science and Technology Culture Programme is a new programme, launched at the end of 2006. Its main objectives are to promote the diffusion of scientific information throughout the country, sensitise the youth to science, develop actions within schools and universities, and promote contacts between scientific actors, business people and the public at large. Planned activities include exhibits, conferences, debates and "science cafés" with the participation of eminent scientific personalities.

3.2.5 *The CNRS Associated Research Units / Unités de Recherche Associées (URA)*

The CNRS Associated Research Units (URA) is also a new programme run in parallel to the Research Grant Programme (GRP) described above. It is part of a number of initiatives launched by the CNRS following the adoption of the Science, Technology & Innovation Policy (STIP) in 2006. The main objective is to promote and strengthen Lebanese research teams working in association with the CNRS affiliated centres. The first call for applications was published on the CNRS website in early 2007.

This programme is, in part, a recognition of the relatively important but underexploited research potential in applied science and technology for national development, in Lebanese universities, and an attempt to support collaborative research programmes so that specialised experts have access to the most advanced instruments and techniques in the country.

3.3 *The higher education system and the role of universities in research*

Historically, Lebanon has been home to prestigious higher education institutions. Before the civil war, Lebanon had one of the best university systems in the Middle East, and was a magnet for foreign students.

The number of private institutions of higher education in Lebanon has recently mushroomed to such an extent that figures vary from one source to the other. According to the Ministry of Education and Higher Education (MEES, 2007), there are now 41 institutions of higher education of which 20 have been accredited as universities (see Table 1). At the time of independence, in the mid 1940s, they were three active private universities¹⁰ of which two dominated the higher education scene (AUB and USJ) up to the 1950s when the only public university, the Lebanese University was established. Two more private universities were created soon afterwards: the Haigazan University in 1955, founded by the Union of the Evangelical Churches in the Near East and the Armenian Missionary Association of America, and the Beirut Arab University (BAU) in 1960, subsidised by the late Egyptian President Gamal abd el Nasser and academically affiliated to Alexandria University in Egypt. These two examples are characteristic of the Lebanese private universities: most of them have a confessional origin or basis and many of them are a systematic extension of a "mother institution" outside Lebanon or a blueprint of a foreign model with little effort, if any, to adapt the model to the local situation.

No new university was created during the following 26 years, until the last years of the civil war when two new private universities were born: Notre Dame University (founded by the Maronite order of the Virgin Mary) and the University of Balamand (founded by the Greek Orthodox Church). Between 1990 and 2001, ten new universities (or half of the currently functioning Lebanese universities) were created, six of them in three years (1999-2001). Except for the last one, the Lebanese International University (formerly Bekaa University), none of them have S&T Faculties or carry out much research. They concentrate on applied disciplines such as management, business, administration, social and political sciences, computer sciences, applied oriented studies in public health and religious studies. Most of them are institutions for the transmission of "second-hand" knowledge.

The proliferation of private universities and the exacerbation of their confessional character is a product of the socio-political situation prevailing in Lebanon since 1975. Yet, their religious or confessional orientations do not prevent them from adapting to higher education market rules and to competing for "clients", i.e. students. The uncontrolled proliferation of the higher education institutes and university colleges during the last 10 years follows the same trend.

This development has contributed to a marginalisation of scientific research to the benefit of training and the delivery of professional diploma as well as to the formation of a scattered scientific community lacking a coherent and national research strategy. Another area of concern is the absence of significant PhD programmes and uniform academic standards. The youngest universities are focusing on degrees at the BSc, MSc and MD levels. With more graduates being produced than the local market can absorb, universities are creating a pool of unemployed or underemployed graduates. This overproduction combined with a persistent political and socio-economic crisis results in a mass exodus of graduate students, in other words, a significant "brain-drain".

¹⁰

La Sagesse University was closed between 1913-1961.

Table 1: Lebanon's 20 universities by chronological order of creation

University	Year of foundation	S&T Faculties	Total Faculties
American University of Beirut (AUB)	1866	5	7
Saint Joseph University (USJ)	1875	4	12
La Sagesse University	1875	-	13
Lebanese American University (LAU)	1924	2	4
Saint Esprit de Kaslik University (USEK)	1949	3	13
Lebanese University (UL)	1953	8	15
Haigazian University	1955	-	3
Beirut Arab University (BAU)	1960	4	9
Notre Dame de Louaizeh University (NDU)	1986	2	6
Balamand University (BU)	1988	4	6
Al-Manar University (MUT)	1990	1	3
Islamic University of Beirut	1996	-	1
Islamic University of Lebanon	1996	1	5
Antonine University (UPA)	1996	1	4
Global University	1999	-	3
Al-Jinan University	1999	-	4
Makassed University	2000	-	3
Arab Open University	2000	-	-
Middle East University	2001	-	3
Lebanese International University (LIU)	2001	4	6

3.3.1 *A growing number of students*

With approximately 150,000 students for some 4 million inhabitants, Lebanon has a comparatively high enrolment ratio. Latest figures for the current academic year (2006-2007) show that student registration continues to grow. Thus, 71,457 students registered at the UL in 2006 as compared to 70,627 the previous year (see Table 2). The number of registered students has steadily risen from 80,000 at the end of the civil war to 119,463 for the 2000-2001 academic year, and 146,967 for 2005-2006.

Table 2: Registered Students in Lebanon's higher education institutions (2005-2006)

University	Total Faculties	Total number of students	% of students
Lebanese University (UL)	13	70,627	48.1
Beirut Arab University (BAU)	9	13,653	9.3
Saint Joseph University (USJ)	12	9,718	6.6
American University of Beirut (AUB)	7	6,933	4.7
Saint Esprit de Kaslik Univ. (USEK)	13	5,949	4.0
Notre Dame University (NDU)	6	4,677	3.2
Lebanese International Univ. (LIU)	6	4,722	3.2
Lebanese American Univ. (LAU)	4	4,529	3.1
Balamand University (BU)	6	2,813	1.9
32 additional universities and institutes	-	23,346	15.9
Total	-	146,967	100.0

Source: Ministry of Education and Higher Education, 2007

The overall increase in the number of female students from 48% in 1995 to 53.4% today, has strengthened this trend. This is largely due to the large number of female students at UL (49,252, i.e. 2/3rds of the student population compared to 35% at NDU, 39% at BAU and 48% at AUB. There are many explanations for these differences. Female students at UL are particularly numerous in the Faculty of Humanities as well as, but to a lesser extent, in the Faculty of Law and Sciences, faculties for which there is no compulsory entrance exam. Female students are also particularly numerous in the BSc levels for which the UL tuition fee is minimal (US\$150 a year compared to US\$10,000 or more in the most prestigious private universities). Wealthier families enrol their sons in the more prestigious private universities or send them to study abroad.

The Lebanese University (UL), with over 70,000 students or approximately half of the country's university student population,¹¹ is by far the largest higher education institution in Lebanon. It is followed by the Beirut Arab University (9.3%), the Saint Joseph University (6.6%) and the American University of Beirut (4.7%). These four universities are home to 2/3rds of the country's student body (68.7%). The nine leading universities are presented in Table 2. They account for 84.1% of the students. At the other end of the spectrum, there are many higher education institutions with fewer than 1,000 sometimes fewer than 100 students. More than half (53.2%) of the students are in Beirut, 17.4% in the North, 15.3% in the South and 9.6% in the Bekaa region. Given that UL is the only public university in Lebanon, more than half (51.9%) of the students are enrolled in private institutions of higher education. Except for the Palestinian Territories (58% in 2004: UNESCO Institutes for Statistics 2006), this is the highest figure in the region.

According to UNESCO statistics, in 2004 there were more foreign students in Lebanon (13,930) than Lebanese students in foreign universities (11,286) (UNESCO, 2005). The top five destinations (host countries) for outbound students are France (4,671), USA (2,179), Germany (976), Italy (577), and United Kingdom (575). During the recent years, there has been an important increase of Lebanese students in most of these countries, especially in the United States. Given the estimated size¹² and the characteristics¹³ of the Lebanese diaspora throughout the world, the number of Lebanese students in foreign universities published by Unesco is probably grossly underestimated. One of the reasons is that more than half of the Lebanese emigrants have been granted a second nationality (Kasparian, 2003)¹⁴ and many Lebanese students studying in a foreign university may not be registered as Lebanese.

¹¹ Less than half if the percentage is calculated on the basis of all institutes of higher education and more than half if only the 21 universities are considered.

¹² The total number of Lebanese people living abroad is estimated at approximately 9 million, although figures vary between 4 million (lowest estimate) and 15 million (highest estimate).

¹³ A recent study on Lebanese who emigrated since 1975 and have close relatives in Lebanon shows that 25.4% of them have a university diploma, compared to 8.1% in Lebanon (Kasparian, 2003).

¹⁴ 61.5% in Europe, 75.4% in North America and 87.8% in Australia (Kasparian, 2003: page 15).

Statistics on teaching staff in Lebanon are difficult to obtain and sometimes are kept as secret as a war treasure. Published statistics (e.g. on the web pages of Lebanese universities) must be taken with some degree of caution. They may vary substantially from one source to the other and may in particular be unrealistically high. Teaching staff is very fluid in all the universities, with a large number of part-timers who teach in many different universities and thus may be counted twice or more.

Given the fact that recruitment levels have been very low during the last 10-15 years, most of them are employed on contract and paid (most often under-paid!¹⁵) by the hour, month or year. Thus, more than 2/3rds of the UL (69.6%) and USJ (77.2%) teachers are temporary employees.¹⁶ Most of them (if not all) are teaching in several other universities. Many permanent employees (called "*titulaires*" at UL and "*cadrés*" at USJ) also hold part-time teaching positions in other universities. Many staff from Lebanese research institutes also work as part-time university teachers.

Some temporary teaching staff teach up to 400 hours a year in several universities and in several regions, with little hope of ever becoming fixed-term or permanent staff. Since they work in many different universities, they seldom have a real home base anywhere and cannot seriously contribute to counselling students or participate in any serious research. This situation has gradually led to the proletarianisation of the teaching profession in higher education in Lebanon.

Table 3: Teaching staff in Lebanon's higher education institutions (2005-2006)

University	Teaching staff		
	Women	Men	Total
Lebanese University (UL)	1,233	3,157	4,390
Beirut Arab University (BAU)	246	424	670
Saint Joseph University (USJ)	763	1,067	1,830
American University of Beirut (AUB)	294	519	813
Saint Esprit de Kaslik Univ. (USEK)	381	775	1,156
Notre Dame University (NDU)	162	347	509
Lebanese International Univ. (LIU)	221	332	553
Lebanese American Univ. (LAU)	71	105	176
Balamand University (BU)	294	643	937
32 other universities and institutes	808	1928	2736
Total	4,473	9,297	13,770

Source: Ministry of Education and Higher Education, 2007

The Ministry of Education and Higher Education (MEES) is the only central source for statistics on teaching and administrative staff in universities throughout the country (see Table 3). But MEES figures do not distinguish between part-time and full-time staff, nor between contractual and permanent staff. Spot checks in three universities confirmed the hypothesis that Ministry figures were inordinately high. According to the Ministry, the UL has a staff of 4,390 whereas UL offices report 2,900 (971 full-time titular staff, 379 yearly contract staff, and 1,550 hourly temporary staff). The Ministry reports 1,830 for USJ, whereas the Vice Chancellor claims to have a staff of 1,547 (352 full-time titular and 1,195 part-time temporary staff). According to the Ministry, AUB has 813 staff members while AUB reports 646 (402 full-time and 244 part-time temporary staff). Consequently, the total teaching contingent in Lebanon's higher education system today is well below the 13,770 reported by the Ministry for 2005-2006 and is probably under 10,000.

¹⁵ Temporary staff at UL is paid between US\$20 and US\$30 by hour, depending on qualifications and experience.

¹⁶ To the best of our knowledge, AUB is the only university with more full-time titular staff (402) than part-time temporary staff (244).

Most scientific research in Lebanon is concentrated in very small number of higher education institutions. Moreover, dynamic individuals, building on their earlier achievements abroad, usually champion the most productive research, often with little institutional incentive. In many Lebanese universities, the absence of an incentive reward and punishment system inhibits dynamic research. Furthermore, many Lebanese universities are applying outdated internal regulations and bylaws on promotions, merit recognition and workload. The absence of any meaningful collaboration between researchers or between groups working on related or similar topics, whether from the same or different institutions, makes the problem worse. Critical mass is generally lacking. Human and financial resources are being increasingly fragmented as more universities, usually unable to provide the proper conditions for research, are being established. The increase in the number of universities may not have a positive effect on the country's research and development, as many of these universities cannot or do not want to undertake serious research and link it to their teaching activities.

This background stresses the importance of developing programmes and mechanisms to encourage isolated researchers with the best qualifications to engage in research projects, establish research groups and participate in research networks, in order not to lose their competitive edge and fall behind advances of modern science. As reported above, the CNRS has started to develop such programmes and mechanisms. A few universities have also started to do so during the last 10 years. The institutional initiatives introduced recently in the three leading research universities (AUB, USJ and UL)¹⁷ are summarised below.

Promoting research at the American University of Beirut (AUB)

All full-time staff at AUB are obliged to conduct research and to publish ("or perish"). Examples of AUB staff being dismissed after a regular evaluation because they had not published enough were confirmed during our interviews. On the whole, AUB has an enabling environment for research thanks to its independence, relatively streamlined management, good salaries, pleasant working environment, clear rules and accounting methods, and the fact that leading staff members and AUB services promote research initiatives. It is worth noting that a staff member who succeeds in attracting substantial research funding can "buy" part of his/her teaching time off.

There are two entities that play an important role in this system: the University Research Board (URB) and the Office of Grants and Contracts (OGC). The role of the URB is to foster and improve the AUB research environment. Currently, the URB is supporting the AUB faculty by providing 1) short- and long-term development grants primarily for short-term travel to conferences and workshops to present research and long-term visits to research facilities, and 2) research grants for regular research in individual, group or collaborative research projects, and "seed grants" for newly appointed faculty members. The URB manages a research grants programme with two calls a year and a yearly budget of approximately US\$1,000,000. Part of this amount comes from the Medical Practice Plan (MPP), a separate programme for the Faculty of Medicine that requires each medical doctor on the faculty to accept a deduction from his/her salary that is used to feed a faculty research fund which has a yearly budget of approx. US\$250,000.

In 2000, AUB created the Office of Grants and Contracts (OGC) to assist the faculty and to manage the increasing number of university and sponsored research grants. The OGC is involved in both pre-award and post-award (grant administration) operations. Pre-award functions include assistance in identifying funding sources, disseminating regular reports on funding opportunities, assisting faculty members in the preparation of proposals, up to the formal submission stage, and then following up on their status after submission. It is worth noting that AUB makes an advance payment as soon as a contract is signed. The current OGC Director is the University's contracting officer. She works in a pleasant, functional office and is assisted by three full-time officers. For the 2005-2006 academic year, the AUB research budget is estimated at US\$2,500,000 (including the URB research grant

¹⁷

Similar initiatives have recently been launched in a few other universities, e.g. a Research Council has been established at the University of Balamand, and the newly created "Balamand Internal Research Grants" programme awarded 12 grants during 2006, its first year of operation.

programme), and total funding for R&D for this academic year amounted to US\$6,794,887 (see Table 4).

Table 4: Grants awarded to funding R&D activities at AUB (Academic year 2005-2006)

Sponsor category	Funding (US\$)	Number of grants
Lebanese Government ¹⁸	1,186,619	44
US Government	474,420	3
Foundations	760,448	7
Private sector	903,280	30
Institutions ¹⁹	103,559	4
NGOs	2,362,790	18
URB	756,296	118
MPP	247,475	27
Total	6,794,887	251

External funding sources are far greater than funding from the AUB budget. Medical research is the main recipient area. The NGOs include a number of North American NGOs. The foundations include the Arab Science & Technology Foundation, Welcome Trust, Ford, etc. The private sector includes many pharmaceutical companies (e.g. Novartis).

Promoting research at Saint Joseph University (USJ)

Research funding at USJ is more internally oriented than at AUB. Prior to the creation of the Research Council in 1995, USJ did not provide any direct support for research activities. The Research Council, chaired by the Vice Chancellor of the USJ, was created to promote research activities within the University. Its main operating mechanism is the USJ research fund managed by the Vice Chancellor for Research. The USJ research fund supports PhD studies, field research, and both basic and applied research.

Over the last 12 years, more than US\$ 7 million have been awarded and close to US\$ 6 million have been spent. At present, the annual budget is slightly under US\$ 1 million. Each institution of USJ contributes 1.5% of its budget to the research fund. Past activities include 266 research projects and PhD theses as well as attendance at some 15 international conferences; 129 research projects and 55 PhD theses are currently being supported by the research fund. The main recipient disciplines are arts and social sciences (25.35%), medicine (17.62%) and basic sciences (7.38%). There is no ceiling to the grants. A grant may vary from US\$550,000 for a socio-economic project on the integration of young Lebanese in working life and emigration (Kasparian, 2003) to a few thousands US\$ for a smaller project. The project budget always includes an item for the dissemination of research results in one form or the other (publications in peer reviewed journals or an USJ journal, books, conferences).

According to the USJ vice chancellor for research, the USJ research fund has been instrumental in promoting PhD studies and in encouraging more USJ staff to do research, which, actually, is carried out by an estimated one-third of the 352 titular staff (*cadrés*) but very few of the 1195 temporary part-time staff. Research work is still individual and fragmented, but is increasingly structured around USJ's 20 research laboratories and 16 research centres.

¹⁸ This primarily includes grants received from the CNRS but may also include funds from EU via Lebanese governmental agencies.

¹⁹ This may include institutions e.g. universities in North America or Europe.

Promoting research at the Lebanese University (UL)

The first real efforts to structure and promote research activities at UL were made in 2001 when the Central Committee for Research (CCR) was established. Prior to 2001, the UL had an estimated annual research budget of approximately US\$ 1-2 million. For a variety of reasons, it was never completely spent. The main CCR mechanism for allocating funds is the research grant scheme. The first call for applications was launched in 2001 and the first grants awarded in 2002. Between 2002 and 2006, 549 applications were received and 234 projects were approved. Each project is evaluated by at least two UL staff members whose names are normally kept confidential²⁰. Altogether 510 researchers are involved in these research projects (an average of slightly more than two researchers per project). An average grant is approximately US\$10,000 (more for basic sciences and less for social sciences). It is paid in three instalments. A progress report is required six months (maximum one year) after a contract has been signed. This is a prerequisite to the disbursement of the second instalment. A final report has to be sent in at the end of the project.

Although the research grant scheme is open to all disciplines, 60% of the grants and an even higher percentage of the budget have been allocated to the basic sciences. The other disciplines, except for economics (19 grants) and media/communications (13 grants), received fewer than 10 grants between 2002 and 2006 (socio-anthropology 9, psychology 5, philosophy 1). There are several reasons for the relatively low number of applications in the social sciences and humanities. UL staff members in these disciplines are reluctant to be evaluated, in particular by their closest colleagues,²¹ and some (among the most active?) may prefer to participate in consultancies where profits are higher. The number of applications increased during the first two years, with a peak in 2003 (223 applications submitted and 113 grants awarded), and then sharply and steadily declined, probably because most potential grantees, except in the social sciences, applied in the second and third years. If this hypothesis is true, we can estimate the approximate number of UL staff working in research. The budget has never been an issue; more grants could have been funded.

Despite efforts made since 2001, research activities at UL are still largely based on individual researchers linked to their training laboratories abroad (mainly in Europe) and supported by bilateral research programmes. Without reward and/or punishment for research output, the "old guard",²² i.e. the titular staff with lifetime jobs, have little incentive to carry out research. In fact, most of the research at the UL is carried out by fixed-term (yearly) and temporary (hourly) staff who are longing for a more secure position.

Excellent human resources provide UL with the largest potential for research activities in Lebanon today, but the university is confronted with a number of lingering structural problems that prevent the staff from engaging more actively in research and performing more satisfactorily. This statement is supported by the conclusions of a recent internal University-wide evaluation report. As far as research is concerned, the report states that UL is lacking:

- 1) adequate infrastructure to carry out scientific research in the basic sciences;
- 2) sufficiently well equipped laboratories in most areas;
- 3) permanent research teams, and
- 4) clear institutional rules and mechanisms that promote the management, funding, evaluation, and dissemination of research activities in the UL as well as research policies as a whole.

²⁰ In case of a conflicting evaluation, a third opinion is solicited.

²¹ Given the fact that the evaluation is internal to the UL and given the size of the community, it is not too difficult to guess who the two anonymous evaluators are.

²² Since recruitment has been stopped for the last 10 years, this population is ageing. It is estimated that the average age of titular staff and yearly contract-based staff at UL at present is 56 years old.

The report went on to propose a number of actions:

- 1) the creation of a trans-faculty doctoral school (*Sciences, Technology and Health*);
- 2) the formation of research teams in partnership with the CNRS;
- 3) the development of a database on researchers, research equipment and research activities at UL;
- 4) the development and/or strengthening of research centres in cutting edge areas of research focused on equipment pools or platforms;
- 5) the creation of an institutional mechanism at the university and faculty level to manage research funding (with a well-defined research budget), evaluations, publications, etc.

The first three actions have been launched; the last two still have to be worked out.

3.3.4 *PhD students and PhD programmes*

The strength of a research laboratory or institution and of a national research system depends largely on productive PhD students. Interviews confirmed that most Lebanese PhD students (particularly in the basic sciences) are trained abroad. This is due to the lack of accredited PhD programmes in Lebanon. English speaking students often go to a private English speaking school, study for their first degree at AUB and their PhD in an English speaking country (mainly US and UK), and then eventually return to Lebanon (often AUB) as a staff member. The itinerary of a French speaking Lebanese student is more varied although the majority of them would tend to go to France (or Québec/Canada) for their PhD studies. We do not have information on the rate of return, although we know that Lebanese people in the diaspora are even better educated than in Lebanon (see note 13).

Except for medical sciences, some disciplines in the arts, and religious studies²³, PhD programmes in Lebanese universities have not yet been started or need to be re-activated. Some PhD students are conducting their PhD studies in Lebanon under the joint supervision of their home university and a foreign university; it is very difficult to get precise information on the number of PhD students presently contributing to research activities in Lebanon. Students registered abroad can also contribute to research activities in Lebanon, albeit indirectly. At the AUB, a doctoral programme in philosophy was started in 1961. The first PhD was awarded by the Department of History in 1966. During the next decade doctoral degree programmes were also started in the Faculty of Arts and Sciences (Arabic, Arab History, Chemistry and Physics) and the Faculty of Medicine. In the mid 1970s, when the civil war broke out, the PhD programmes were frozen. By that time 94 PhD degrees had been awarded. PhD programmes are being revived at AUB. There are eight PhD programmes in the arts, sciences (physics and molecular biology) and engineering that have been registered or are pending registration by the New York State Education Department (NYSED) and should begin in the fall term of 2007. Since 2000, USJ has awarded 70 PhDs under dual supervision arrangement and UL awarded 258 mainly in Arts and Humanities and the Social Sciences. At UL there is a project to establish a multidisciplinary trans-faculty doctoral school called STEM (Sciences, Technology, Environment and Medicine) that is ready to be implemented pending government authorisation. The authorisation has so far been given in February 2007 for the creation of three new Doctoral institutes at UL: 1) Sciences, Technology and Health, 2) Political, Legal and Administrative Sciences, 3) Social Sciences and Humanities.

²³

At USJ, the first doctorates in theology were awarded in the late 1880s following accreditation by Pope Léon XIII in 1881. Further, 41 doctorates in medicine, called "Diplôme spécial français", were awarded between October 1887 and November 1894.

3.4 The national research institutes

There are currently six main national research institutes or centres outside the higher education system in Lebanon. Four of these are funded and under the control of the National Scientific Research Council (CNRS), one under the Ministry of Agriculture and the last one under the Ministry of Industry. Other institutions include the Central Administration for Statistics (CAS), the Centre for Educational Research and Development (CRDP), the Lebanese Standards Institution (LSI or LIBNOR), the Institute for Development, Research and Applied Care (IDRAC) and the Lebanese Centre for Policy Studies (LCPS) (see Table 5).

Table 5: The Lebanese National Research Institutes (chronological order of creation)

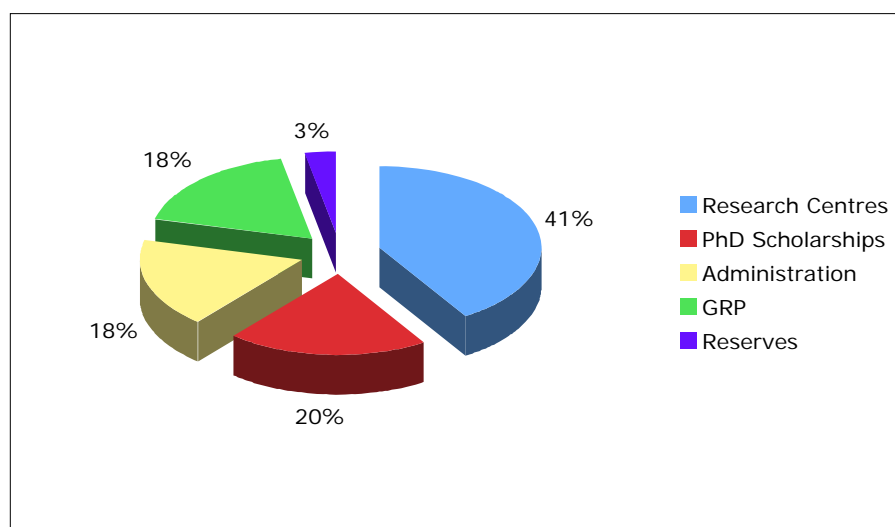
Institute	Year founded	Supervisory body
Industrial Research Institute	1953	Ministry of Industry
Lebanese Standards Institution	1962	Ministry of Industry
Lebanese Agricultural Research Institute	1964	Ministry of Agriculture
Centre for Educational Research and Development	1971	Ministry of Education and Higher Learning
Centre for Geophysical Research	1975	CNRS
Centre for Marine Sciences	1977	CNRS
Central Administration for Statistics	1979	Presidency of the Council of Ministers
The Lebanese Centre for Policy Studies	1989	NGO
Institute for Development, Research and Applied Care	1995	NGO
Centre for Remote Sensing	1995	CNRS
Lebanese Atomic Energy Commission	1996	CNRS

The latter institutions focus more on service or policy studies. They generally have a limited core executive and research staff and rely heavily on *ad hoc* research associates as consultants, e.g. LCPS. Most of these research associates are employed by the Lebanese universities. In November 2002, a technological pole called Berytech, was established mainly as an incubator to help create companies. In addition, there are also a number of associations such as the Lebanese Association for Educational Studies (LAES) and the Association of Lebanese Industrialists (ALI).

The four CNRS research institutes, the Lebanese Agricultural Research Institute (LIRA) and the Industrial Research Institute (IRI) are presented below. Information on the other institutes can be found on the Web.

As part of its implementation function, the CNRS manages the four research centres mentioned in Table 5. Out of a total budget of 8.65 billion of LBP in 2006 (or USD 5.766 million), CNRS is spending 41% to operate its four research centres (see Figure 4). Despite repeated promises to receive 1% of the national budget, the CNRS budget, at present, corresponds to approximately 0.1% of the national budget. Yet, given the present zero recruitment policy, if the CNRS was granted a substantial budget increase, it may have difficulties to absorb it. Except for the Lebanese Atomic Energy Commission, the CNRS research institutes are seriously handicapped by their lack of permanent qualified research staff and field assistants.

Figure 4: CNRS budget distribution



3.4.1.1 The Centre for Geophysical Research

The Centre for Geophysical Research (CRG) is the oldest of the CNRS centres. It was established by a decision of the Council of Ministers dated May 3, 1975, to take over the responsibilities and duties of the Ksara Observatory. In its establishing decision, the Council of Ministers gave the CRG a clear though manifold mandate: monitor seismic activity, both natural and manmade, throughout the national territory; conduct geomagnetic and gravity observations; identify active faults in view of alleviating damage from eventual earthquakes, and conduct geophysical investigations on mineral and other natural resources.

Since its creation, the CRG has developed a partial real-time network of six seismological stations registered internationally under the acronym, GRAL (Geophysical Arrays of Lebanon). This network covers the national territory and publishes a monthly bulletin entitled "The Provisional Seismological Bulletin", which is distributed to the main institutions in Lebanon as well as interested private parties and international data centres. The Centre also runs the Qsaybeh geomagnetic observatory, a member of the international Intermagnet Network.

In order to identify active faults, the CRG has conducted two GPS surveys, namely, a paleoseismological trenching of the main Levant fault system, the Yammouneh fault, a segment of the Levant transform fault, and offshore, an oceanographic study for a maritime region of 27 km². Precise bathymetry, a seismic reflection survey, and other oceanographic techniques were acquired during a joint operation with IFREMER, the French research institute for exploitation of the sea.

The CRG is an active member of EMSC (Euro-Mediterranean Seismological Centre), a founding member of a joint initiative of the USGS (United States Geological Survey) and UNESCO that addresses earthquake risk in the Eastern Mediterranean through RELEMR (Reduction of Earthquake Losses in the Eastern Mediterranean Region). The CRG has developed long-term scientific partnerships with prominent laboratories in France, namely, the IGP (Institut de Physique du Globe de Paris), the CEREGE (Centre Européen de Recherche et d'Enseignement des Géosciences de l'Environnement), the LGIT/Grenoble (Laboratoire de Géophysique Interne et de Tectonophysique) for a project on seismic microzonation of the city of Beirut.

The CRG is eager to further develop its seismic network and is looking for partners in satellite geodesy. It also tries to fulfil its obligations towards the civil society by striving to produce an early warning system concerning tsunami threats in the Mediterranean and raising the level of public awareness by publicising good practices for earthquake mitigation in Lebanon.

3.4.1.2 Centre for Marine Sciences

The Centre for Marine Research (CRM) was established in 1977. The decision to establish such a centre was taken as a national response to the 1972 Stockholm Conference. The Ford Foundation and UNESCO played important roles during the formative years. Today the centre is a recognised institute within the Mediterranean network of marine centres and participates in a number of regional and international activities. The centre remained fully operational during the war years and has several major accomplishments to its credit, e.g. the implementation of a national coastal monitoring programme, a general biodiversity survey, feasibility studies for contingency planning, and mariculture development. The centre's library, located in Batroun, is open to specialists and the public at large. It is the national depository for all the publications of the Intergovernmental Oceanographic Commission.

The CRM has a number of relatively well equipped laboratories, located both in Batroun and Jounieh, to conduct its activities in primary and secondary production, physiology, bacteriology, benthology, general and analytical chemistry, physical and operational oceanography. Its main research focuses on coastal monitoring programmes, assessment of oil spill impact, coastal and offshore hydrobiological parameters (SESAME project, EU), red tide and toxic algae, heavy metals in biota and sediments, biodiversity using biota to evaluate the chemical contamination in water and sediment (Mytimed project, EU), the study of coastline karstic water, quality of rivers water, and coastal dynamic. Biological and hydrological marine databases are available and are being further developed, e.g. the ongoing EU project called SeaDataNet, a Pan-European infrastructure for Ocean & Marine Data Management. CRM needs more permanent research staff and field work assistants to carry out all its ongoing projects satisfactorily. It also needs more offshore equipment.

Several agreements and protocols govern CRM's relationship with many regional and international organisations. The major agreements covering joint research activities, joint supervision of research projects and advanced training involve:

- various ministries and universities in Lebanon,
- marine centres in Syria (Lattakia), Cyprus and Turkey,
- the Inter-Islamic Science and Technology Network on Oceanography (INOC), Izmir, Turkey,
- various Mediterranean centres and organisations through joint projects financed by the European Community,
- IFREMER, CNRS, INAP-G and different universities in France,
- European Union, UNEP (MEDPOL, RAC/SPA....) IAEA.

3.4.1.3 The Centre for Remote Sensing

The Centre for Remote Sensing (CRS) was established in 1995 and became fully operational in 1997. The creation of a Lebanese CRS came as the culmination of a focused effort to catch up with recent advances in remote sensing and geographic information system (GIS) technology.

The CRS has carried out various studies dealing with watershed and forestry management, urban settlements, archaeology and the environment, integrated coastal zone management, public participation, natural hazards, and is now in the final phase of producing the greatly needed soil map of Lebanon. Furthermore, the Centre is obtaining upgraded information, and is cooperating with several development projects devoted to environmental monitoring and data acquisition in various sectors. It is also producing thematic maps and training government staff on the requirements and applications of remote sensing and GIS.

The CRS has been growing steadily in terms of its scientific output as reflected by the number of articles published in scientific journals as well as the number of projects shared with international scientific agencies and its contribution to regional and local scientific workshops.

Its main research fields at present include environment, agriculture, water, soil, marine environment, land cover and use, geology and hazards, and its main projects focus on soil erosion (SIDA, AUPELF, CEDRE), the Litani watershed management (IDRC), the Atlas of Lebanon (CEDRE, CNRS, IFPO), soil and water pollution (CNRS). This work is carried out through three sections: 1. Remote Sensing, GIS and IT, 2. Natural Resources Management, and 3. Environmental Monitoring and Assessment. The main weaknesses relate to the shortage of qualified personnel and lack of capacity building processes. The Centre is also held back by insufficient funding and lack of opportunities for researchers to access international platforms.

The Centre for Remote Sensing has signed a number of project implementation agreements with various national and international institutions and agencies, e.g. Directorate General of Geographic Affairs (Lebanon), ACSAD (Syria), BGR and GTZ (Germany), EU-Soil Bureau, AUPELF, and IFPO (France, formerly CERMOC), Cornell University (United States), Center for Remote Sensing of the Mediterranean (Italy) and CIHEAM (Bari, Italy).

3.4.1.4 The Lebanese Atomic Energy Commission

The Lebanese Atomic Energy Commission was established in 1996 with the technical support of the International Atomic Energy Agency (IAEA).

LAEC's mandate is:

- to establish the necessary national radiation protection infrastructure in order to regulate the use of and protection against ionizing radiation (creation and maintaining of the national register of radioactive sources, issuing regulations, delivering licenses and authorisations for import-export and the use of radiation sources, permanent monitoring of radiation in the environment, etc.);
- to ensure the safety and security of radioactive materials, to participate in combating the illicit trafficking of nuclear materials;
- to fulfil the technical requirements of ratified conventions with the IAEA and the promotion of peaceful use of atomic energy.

This mandate has been given to LAEC through decisions and regulatory decrees adopted by the Council of Ministers.

LAEC employs close to 60 persons (15 researchers and senior researchers, 30 engineers, inspectors, laboratory assistants, technicians, and 13 support staff), and hosts more than 15 PhD and MSc students. LAEC is composed of five departments (Research and Development, Radiation Environmental Monitoring, Nuclear Security and Emergency, Radiation Safety Services, and Inspection-Authorization-Regulation). Each department is composed of two to four sections depending on its mandate.

The Department of Research and Development is composed of eight laboratories (Electrostatic Accelerator, Gamma Spectroscopy, Alpha and Beta and X Spectroscopy, Materials for Radiation Detection, Organic Pollutants Analysis by Separation Methods, Water Analysis and Hydrology, Radioimmunity Assay, and Secondary Ion Mass Spectrometry). The research topics conducted at LAEC are: 1) interaction of organic pollutants with soil using TOF-SIMS techniques, 2) Water analysis development of new treatment methods and analysis of stable isotope ratio, 3) Analysis of organic pollutants in environmental matrices, 4) Development of new chromatographic separation methods, 5) Radionuclide interaction with complex system, and radionuclide assessment in chemical industrial wastes, 6) Elemental and composition determination for geological samples, 7) Aerosol elemental analysis, 8) Radon evaluation in water, soil and raw building materials, 8) Authenticity and provenance studies for archaeological and art materials, 9) Semi-conductors and room temperature nuclear detectors, 10) Quantification and control of active ingredients in solid drugs, 11) Analysis of biological samples using nuclear techniques, and 12) Hormone and tumour markers determination using RIA. LAEC also has two radiation control laboratories (Personal Dosimetry and Secondary Standard Dosimetry). The service provider laboratories of the LAEC are in the final stages of ISO 17025 certification.

LAEC's main scientific and technical partners are French universities via CEDRE projects (the 2006-2007 cycles of four CEDRE projects are being implemented in the CLEA laboratories), and the IAEA through its technical regional cooperation projects (LAEC is involved in more than 10 regional projects with the IAEA in the field of radiation safety, use of analytical nuclear techniques, and nuclear instrumentation). It also has several PhD co-advisory agreements. At the national level, LAEC mainly works with the AUB Physics Department, the LU of the Faculty of Sciences (Material Sciences Laboratory), and the BAU Faculty of Pharmacy and Faculty of Sciences.

In 2006 LAEC published 25 articles in international scientific journals and 3 in regional and European journals.

3.4.2 The Lebanese Agricultural Research Institute

As mentioned in the brief historical background above, public agricultural research in Lebanon dates back to the establishment of the Tal Amara station in the Bekaa Valley immediately after independence (1946) as an agricultural training centre, supported by French technical assistance. Later, in 1957, it became the Department of Agricultural Scientific Research (DASR) of the Ministry of Agriculture (MoA). Other stations were established at Tourbol (Bekaa) for animal production, and at Abde (North) and Sour (South) for citrus tree production. In 1964 DASR was reorganised as an autonomous public institution and became the Lebanese Agricultural Research Institute (LARI) affiliated to the Ministry of Agriculture (MoA). Research stations were also established at Fanar (Mount Lebanon) for animal health and agriculture and at Kfarshakhna (North) for soil, irrigation and farm machinery research. In the late 1970s, both Tourbol and Kfardane experimental stations were turned over to the International Centre for Agricultural Research in the Dry Areas (ICARDA).

LARI is the only agricultural research institution in Lebanon, but it is not the only institution conducting agricultural research. Other institutions directly or indirectly involved in agricultural research include the Centre for Marine Sciences (CMS) and four faculties of agricultural sciences (UL, AUB, USJ and USEK)²⁴ as well as other faculties that have highly qualified scientists in fields related to agricultural research such as plant and animal biology, agricultural engineering, food processing, and rural social sciences.

LARI is an autonomous public institution governed by a council composed, *inter alia*, of representatives of the main scientific institutions and agricultural stakeholders²⁵. Its main mandate, which occupies approximately 60% of the time of its senior research staff, is to conduct scientific research for the development and advancement of the agricultural sector in Lebanon. All major agricultural fields are concerned, i.e., field and industrial crops, horticulture, crop protection, irrigation, agro-meteorology, animal production and health, food technology, and socio-economics. In the absence of a national extension service, it also keeps close ties with the farmers, tries to develop research activities aimed at solving their problems, and provides services such as, production of quality seeds, soil analysis, food quality control, etc., to the agricultural sector at large. In addition, most scientific staff members are actively involved in teaching in various Lebanese universities, mainly UL, USJ, AUB and USEK.

In 1975, LARI had 55 researchers and assistant researchers (supported by 66 technicians). Civil conflict has taken a heavy toll. The number has also been sharply reduced as a result of immigration, retirement and deaths, as well as low salaries and benefits which drove the remaining research staff to leave. Till 1995, attempts to recruit researchers were hampered by governmental restrictions and low salaries. Realising that most of the researchers were over 50 years of age, the Government recently recognised the importance and urgency of new recruitments, and is now offering more competitive salaries. But even today, following several recent retirements, LARI only has 10 researchers (PhD), 22 assistant researchers (DEA in agronomy or equivalent), supported by 22 laboratory assistants (MSc in biology or chemistry, agricultural engineers) and technicians. An additional 34 engineers and technicians are employed through a World Bank funded project. LARI's staff is also supervising a number of Lebanese and foreign students who contribute to ongoing research activities; two of them are PhD students. Six new PhD graduates will be recruited as permanent staff before the end of 2007. Although the LARI staff is deeply committed and is highly specialised in a wide range of disciplines, it cannot adequately cover all areas of research. There are too few specialists in several disciplines notably in the social and computer sciences. The senior researchers recruited during the last 5-10 years are mostly graduates from European universities (mainly France, the United Kingdom, Italy and Germany) and are between 30 and 45 years of age. Their salaries are comparable to those of academic staff at the UL. The research assistants are also young graduates from Lebanese, Arab, and European universities.

LARI has seven experimental stations (Tel Amara, Terbol, Kfardane, Fanar, Abdeh, Kfarchakhna, et Tyr) covering 200 hectares of agricultural land. These stations are located in all of Lebanon's agro-ecological zones and are divided into units or sections either by discipline or by crop. During the civil war years, all the research stations lost a large part of their physical resources, i.e. buildings, farm machinery, field and laboratory equipment, transport vehicles, supplies and support services. Toward the end of 1999, work was started to rehabilitate all the stations, starting with the main station of Tel Amara. On the whole, the main stations now have sufficient land for field research, relatively well-equipped laboratories, and a few transport vehicles.

²⁴ The first faculty of agriculture established in Lebanon was the Faculty of Agriculture and Food Sciences (FAFS, 1952) of the American University of Beirut (AUB). Other such faculties were opened later: the Ecole Supérieure des Ingénieurs Agronomes Méditerranéens of Saint Joseph University (ESIAM-USJ, 1979), the Faculty of Agricultural Sciences of the Lebanese University (FAS-LU, 1985), and the Faculty of Agricultural Sciences of Saint Esprit de Kaslik University (FSA-USEK, 1988).

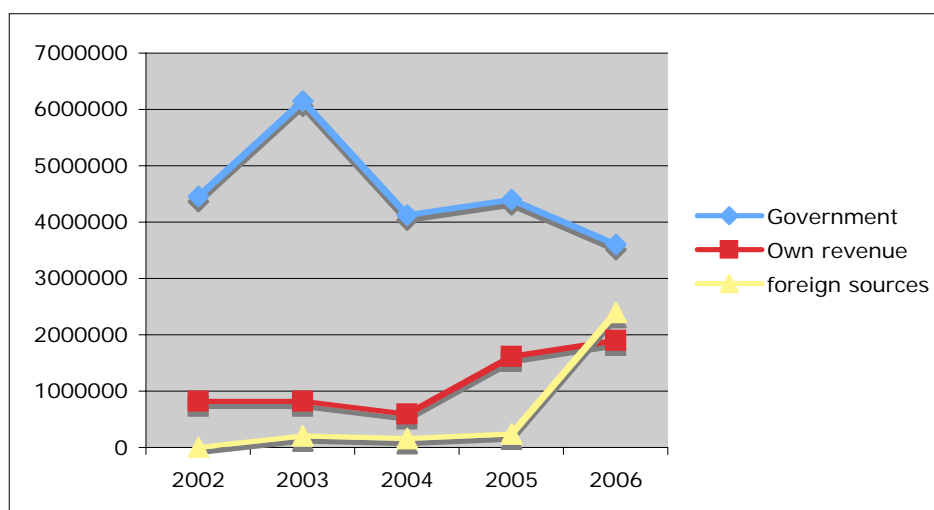
²⁵ Including representatives of the Ministry of Agriculture, some faculties of agriculture, and the private sector, plus the LARI Director General.

Until recently, LARI's budget was paid almost exclusively by the Lebanese government. The size of the budget often fluctuated and was seldom disbursed in full. In 2002, for example, it fell from 13 billion LBP to less than 4.5 billion LBP. Most of the governmental support is allocated to salaries, while operating and capital costs have to be obtained mainly and increasingly from other sources. In 2003 the government contribution to the budget reached a peak of 6.150 billion LBP but has been falling ever since. The government's decreasing share, however has been largely compensated by increasing revenues from LARI's services as well as by bilateral and multilateral funding. The 2006 budget, for instance, amounted to nearly 8 billion LBP of which 45.6% came from the government, 24% from LARI's own revenue and 30.4% from foreign sources (see Figure 5).

Cooperative research projects at LARI are implemented in various fields together with foreign/international institutions, as follows: wheat, barley, grain legumes, pasture and forage with ICARDA; olive propagation and improvement with FAO; quality control on food and water with FAO; plant protection e.g. insect male sterile technique on the Mediterranean citrus fruit fly with IAEA and in collaboration with the Lebanese Atomic Energy Commission; certification programme for fruit tree production with CIHEAM. International agencies such as FAO, IAEA, UNDP/GEF, UNEP, ICARDA, ACSAD, and the World Bank which have sponsored LARI in the past, are expected to continue their support. Collaborative research agreements have been signed with the *Institut National de la Recherche Agronomique* (INRA-France), the International Centre for Advanced Mediterranean Agronomic Studies (CIHEAM) and the Royal Botanic Garden (UK).

Several other collaborative research projects are being conducted with regional institutions, mainly in Syria, as well as with national institutions, such as the four faculties of agriculture, CNRS centres, and various ministries.

Figure 5: LARI's budget structure and evolution (2002-2006) in LBP



In the absence of a national extension service, research findings are directly transferred to the farming community in the following areas: cereals, root crops, pastures, grain legumes, veterinary medicine, plant nutrition, and pest management. Hybrid seed, tissue culture, and biotechnology output are also reaching the farmer thanks to Lebanon's multi-channel system (public and private institutions, and the private sector).

Established in 1953, the Industrial Research Institute (IRI) is a Lebanese institution for making studies, and for industrial research and scientific testing and analysis. The IRI is a not-for-profit institution, linked to the Ministry of Industry, with administrative and financial autonomy.

The IRI activities and services are designed:

- to conduct studies and research relevant to the establishment of new industries;
- to investigate and disseminate information about available raw materials with a view to defining their use and establishing the best means for their exploitation;
- to provide, on an international scientific level, reliable services in testing and analysis and to grant certificates of quality or conformity with standards and purchase specifications;
- to provide specialised technological, management and economic consulting services to existing industries and industrial development schemes;
- to maintain close co-operation, both on the national and international level, with official institutions, industrial organisations, and development boards, in matters relating to the industrial development of the country.

IRI is housed in a spacious new building located on the new campus of the UL. It has well-equipped laboratories in many fields²⁶, a library with up-to-date publications including international standards, several lecture and conference rooms, an exhibition hall, several equipped workshops, and a pilot plant for applied research. It provides training for skilled workers e.g. through the Lebanese Welding Centre. IRI's Sub-Contracting and Partnership Exchange programme (SPX) provides information and advisory services to small and medium enterprises (SMEs) in Lebanon and promotes subcontracting and partnership between Lebanese subcontractors and international SMEs. IRI offers certification that cover systems, products and persons, and has the means and ability to issue technical standards that could be required by certain clients. It also participates in all the technical committees of the Lebanese Standard Institution (LIBNOR) for studying and issuing the Lebanese Technical Standards.

In carrying out its functions, IRI adheres to ethical and professional standards, thereby safeguarding the clients' best interests. It regards any information, processes, patents or techniques developed during work for the client as the client's own property and keeps such matters completely confidential. It was probably because of this confidentiality, that we were unable to obtain the official IRI staff figures and budget, which were grossly estimated to be respectively 100 people and five billion LBP. We estimated that IRI would devote approximately 10% of its resources to research. IRI's core activities are related more to client services, certification and technical standards than to research.

Similarly, we do not have much information about its collaborative projects. Two projects funded by the European Commission are hosted at IRI: the Euro-Lebanese Centre for Industrial Modernisation (ELCIM) and the Lebanese Cleaner Production Centre. The latter project also receives funding from the Ministry of Environment and UNIDO.

²⁶

Such as wet chemistry and physical chemistry; petroleum and petroleum products; bread and wheat; microbiology; paint; textile, rubber and leather; soil mechanics and civil engineering; mechanical engineering, water; metrology and calibration.

3.5 The national R&D capacities and efforts: measuring R&D inputs

For statistical purposes, two inputs are normally measured: R&D personnel and R&D expenditures. Both inputs are normally measured on an annual basis: so much spent during a year, so many person-years used during a year. Both series have their strengths and weaknesses, and, in consequence, both are necessary to secure an adequate representation of the effort devoted to R&D (OECD, 2002). While a certain amount of R&D data can be derived from published and/or non-published internal sources, there is no substitute for a special national R&D survey. Such a survey has never been carried out in Lebanon. What follows is a first attempt to gather existing or reconstructed information as well as estimates from the major national performers of R&D in Lebanon: the main higher education institutions and the public research institutions. In the absence of baseline data, we cannot make a historical comparison or plot a trend.

The estimation of R&D personnel data in Lebanon is problematic, particularly within the universities where the bulk of R&D personnel is presently located. There are many reasons, e.g. the aforementioned fluidity of a large number of part-timers who work in many universities and may be counted twice or more, the difficulty in constructing a fair estimate of the number of university staff truly involved in R&D activities, problems in reducing such data to full-time equivalents (FTE) or person-years spent on R&D, and the fact that there is no single model that can be applied to all universities (at AUB, for instance, most titular full-time staff are actively engaged in research activities, at UL very few).

Head count figures were provided and discussed with the personnel service of each institution (except for IRI and the 7 additional universities²⁷). The estimate of university staff involved in research activities is mainly based on figures from respective research grant schemes over several years and interviews with active researchers and research administrators. The FTE is based on interviews with active researchers and research administrators. The results are presented in Table 6.

Table 6: R&D personnel in Lebanon's research and higher education institutions

	Year	Head Count (HC) of researchers, assistants & technical staff	Estimated Full-time Equivalents (FTE)
Public Research Institutes			
Center for Geophysics – CNRS	2007	6	5
Center for Marine Sciences - CNRS	2007	19	15
Center for Remote Sensing - CNRS	2007	13	10
Lebanese Atomic Energy Commission – CNRS	2007	52	40
Lebanese Agricultural Research Institute (LARI)	2007	90	54
Industrial Research Institute (IRI)	2007	100	10
Higher Education Institutes			
Lebanese University (UL)	2005-06	971 titular 379 fixed-term 1550 temporary	150
Saint Joseph University (USJ)	2005-06	352 titular 1195 temporary	90
American University of Beirut (AUB)	2005-06	392 full-time 194 part-time	100
Other universities (7) less involved in research activities	2005-06	4000 (incl. part-timers many from UL)	100
PhD students for all universities	2007	150	150
Total			724

²⁷

No official figures were provided by IRI. Estimated figures are based on interviews at IRI.

On the basis of the comments and reservations above, the number of persons active in R&D in Lebanon today, calculated in FTE, would be slightly over 700 (724), in other words, slightly under 200 R&D staff for one million people. This is approximately 18 times less than in Europe, and slightly under the regional average.

Tracing the amount and the flow of funds invested in R&D activities in Lebanon is also not an easy task. Most universities do not have an official, transparent R&D budget. In the study, we had to reconstruct university research budgets using figures quoted by the institutions themselves, with no means of verification. These figures included the FTE cost of personnel, based on salary estimates plus a very approximate amount for other current and capital costs. It was also difficult to accurately estimate the institutions' R&D budgets; different institutions included different unrelated items. For public research institutions we did our best to estimate the R&D part and, whenever appropriate, applied the FTE/HC coefficient. The results are presented in Table 7.

Table 7: Lebanon R&D expenditure

	Year	Budget in millions of LBP (including FTE staff cost)	R&D budget in millions of USD
Public Research Institutes			
National Council for Scientific Research (CNRS)	2006	8,650	5.72
Lebanese Agricultural Research Institute (LARI)	2006	7,894	5.22
Industrial Research Institute (IRI)	2006	5,000	0.30
Higher Education Institutes			
Lebanese University (UL)	2005-06	17,100	11.40
Saint Joseph University (USJ)	2005-06	12,000	8.00
American University of Beirut (AUB)	2005-06	26,691	17.80
Other universities (7) less involved in research activities	2005-06	9,000	6.00
Total			54.44

Taking the comments and reservations expressed above into account, the R&D budget as a percentage of GDP²⁸ would be 0.22%. This percentage is comparable to the most recently available regional average, i.e. 0.2% for 2000 (UNDP, 2003), and is equivalent to Egypt and Kuwait, but below Jordan (0.34%) and far below Tunisia (1%). The official target for Lebanon is still 1% by 2010.

²⁸ GDP (PPP) 2005 estimate: \$ 24.42 billion (103rd).

4. Lebanon publications' outputs

Ultimately, scientific research, to be of value, must be available. This is essential for the research scientists, both individually and as a community, and for the users. The most common way of making research public is through publication. Publishing is at the heart of the science. Furthermore, many countries increasingly use publishing figures as a measure of productivity and an important criterion for career advancement. As indicated above, evaluations based on publication count is a process that is already being adopted in Lebanon at AUB and is being introduced in a few other institutions.

A universally used measure of the performance of a country, institution or scientist is the quantity of publications indexed in international scientific publication databases. While the main purpose of these databases is to enable researchers to conduct broad-based, comprehensive searches in their respective fields, they may also be used as a bibliometric tool. If consulted over several years, this tool can be used to analyse trends and the relative position of a country in the world production. The most commonly used database is the US-based Science Citation Index (SCI) which provides access to current and retrospective bibliographic information, author's names and addresses, abstracts, and cited references found in 3,700 of the world's leading scholarly science and technical journals²⁹. In addition to SCI, another database, i.e. PASCAL produced by the French Institute for Scientific and Technical Information (*INstitut de l'Information Scientifique et Technique* - INIST) of the French National Centre for Scientific Research, was also used to expand and refine the analysis. PASCAL not only indexes journal articles (3,085 international titles) but also proceedings, dissertations, books, and reports. With a broader multilingual coverage³⁰ and a special emphasis on European scientific literature in science, technology and medicine³¹, PASCAL may be more appropriate for countries, such as Lebanon, with French-speaking authors and close collaboration with Europe.

Both databases have their limits and drawbacks. They are highly selective and screen only the world's most prestigious journals (in the case of SCI, the ones whose articles are most frequently cited) most of which are published in the North. For the period of reference (1995-2003), Lebanon is represented in PASCAL by only one local journal (the Lebanese Medical Journal published by the Order of Physicians in Lebanon), and it is not represented at all in SCI. Lebanese scientists often publish in local journals such as the Lebanese Science Journal (LSJ) published by the CNRS and the Journal MAGON published by LARI³², but neither of the two is indexed by SCI or by PASCAL. Numerous studies indicate that in any given country-specific field, much of the research produced by developing country scientists is published in local journals (Russel and Galina, 1987; Chatelin and Arvanitis, 1989; Gaillard *et al.*, 2001). Although the tendency of Lebanese scientists to publish in mainstream journals has been going up over the last decade, a large part of their scientific writings remains locally or regionally published and has low visibility. Measuring and analysing the total scientific production of Lebanese researchers would provide interesting additional information to this report. It would require a different but complementary methodological approach using the complete publication lists of a selected population of Lebanese scientists³³.

Regardless of their limitations, SCI and PASCAL are useful tools to identify prolific authors, and productive laboratories and institutions, as well as to indicate the position of a given country relative to world and/or regional scientific production and to recent trends. This is particularly true for the basic sciences whose authors are targeting the world's leading indexed journals as well as medical and engineering sciences (see output of Lebanon's publications below). This is not at all true for the social sciences and humanities that are not adequately represented in international databases and hence are not included in the results presented below.

²⁹ The Science Citation Index Expanded format, available through the Web of Science and the online version, SciSearch, covers more than 5,800 journals.

³⁰ PASCAL source languages: English 76%, French 9%, German 5%, Russian 6%, other 4%.

³¹ PASCAL subject coverage: Medical, Pharmaceutical and Psychological Sciences 31%; Life Sciences, Biology 22%; Engineering Sciences 20%; Physics and Mathematics 15%; Earth and Space 7%; Chemical Sciences 5%.

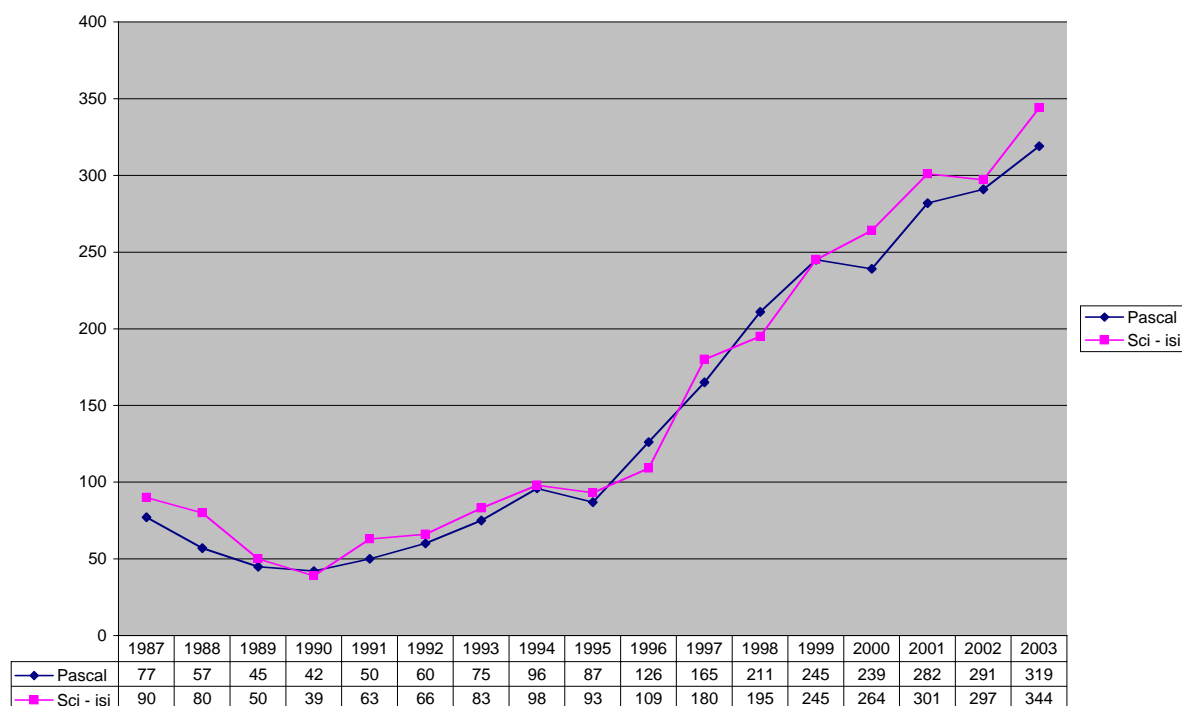
³² This observation is based on a review of a few publication lists of Lebanese scientists in a variety of disciplines.

³³ For a detailed presentation see Gaillard *et al.*, 2001: 49-64.

4.1 Modest but rapidly increasing publication output

Currently, the number of publications of Lebanon indexed in international databases is slightly above 450 per year (in SCI 453 in 2005 and 459 in 2006). Interestingly enough, this number has followed the same trend in both SCI and PASCAL over the last 20 years (see Figure 6). The low years of the curve correspond to the last years of the civil war, with a record low in 1990 (SCI: 39 and PASCAL: 42), i.e. the year following the national reconciliation accord.

Figure 6: Number of scientific publications in Lebanon in SCI and PASCAL



Thomson scientific and PASCAL data, IRD/P.L.Rossi computing

After 1990, the number of publications more than doubled in three years i.e. close to 100 publications in 1994 (PASCAL 96, SCI 98). The increase was even more spectacular after 1995, since the number of publications sprung from slightly under 100 in 1995 to slightly over 450 in 2005, i.e. almost a fivefold increase in 10 years (4.87 for SCI). As an average, this increase has been much more rapid than anywhere else in the world. Thus, the world share (fractional counting³⁴) of Lebanon's scientific publications between 1993 and 2001 has increased from 0.10‰ in 1993 to 0.35‰ in 2004 (see Table 6). The disciplines that have shown the strongest increase are fundamental biology (+632%), astro- and geo-sciences (+509%) and medical research (+259%). The discipline with the highest world share is medical research with 0.62‰, followed by engineering (0.41‰) and mathematics (0.37‰). As a proportion of the world production, these figures are still low however (see the comparison with Thailand, Chile and South Africa in Table 8).

³⁴

In a logical contribution to world science, the author's contributions to each article are fractioned in order to get a total of 100% for the whole group of authors. This type of count, called "fractional", where each article has a unitary weight, is additional in every scale and well adapted to macro-analysis. This type of count is preferable for international visibility comparisons of impact.

Table 8: World share (fractional counting) of Lebanon's scientific publications for eight disciplines (1993, 1999, 2004 and evolution); comparison with Thailand, Chile and South Africa for 2004

Discipline	World share (%) of scientific publications (fractional counts)						South Africa	Chile	Thailand
	Lebanon								
	1993	1999	2004	Evolution 2004/1993 (%)	Evolution 2004/1999 (%)	2004			
Fundamental biology	0,03	0,15	0,24	+ 632	+ 60	2,27	1,76	1,60	
Medical research	0,17	0,40	0,62	+ 259	+ 55	3,05	1,61	1,87	
Applied biology-ecology	0,09	0,14	0,20	+ 123	+ 37	10,59	3,98	2,77	
Chemistry	0,04	0,05	0,11	+ 174	+ 122	2,43	1,96	1,69	
Physics	0,05	0,09	0,14	+ 172	+ 54	1,46	1,52	0,54	
Astro and Geo-sciences	0,06	0,18	0,34	+ 509	+ 84	7,22	4,55	1,69	
Engineering	0,14	0,31	0,41	+ 191	+ 34	2,85	1,70	1,93	
Mathematics	0,15	0,38	0,37	+ 149	- 1	3,18	3,24	0,61	
Total	0,10	0,23	0,35	+ 254	51	3,49	2,07	1,65	
Number of publications	60	166	268	+ 347	+ 61	2 683	1 594	1 267	
Thomson Scientific data. OST computing						OST - 2007			

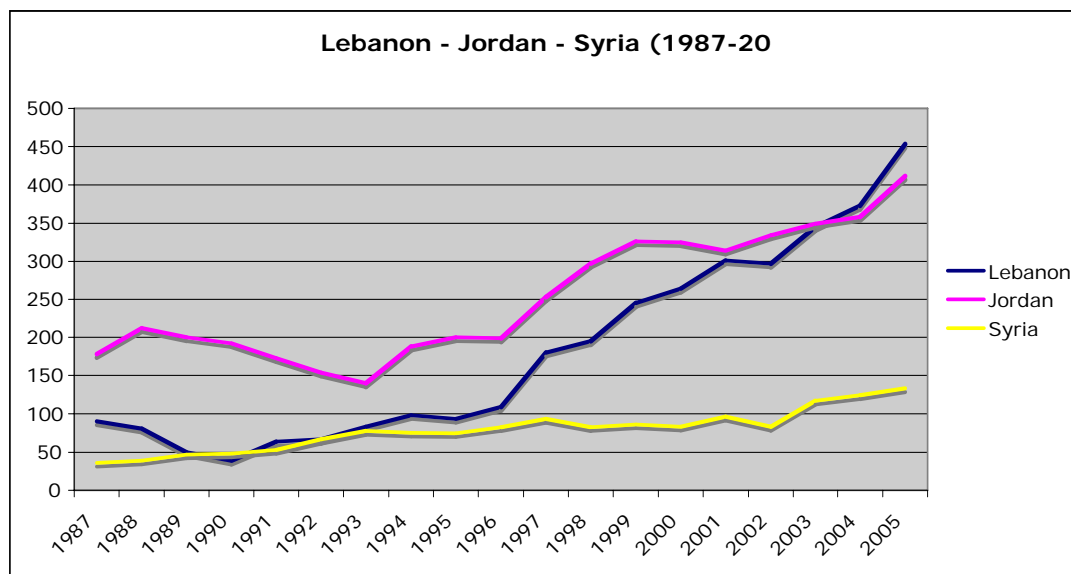
4.2 Regional and international comparisons

Although still relatively small as a scientific country, Lebanon has significantly increased its publication output and world share over the last few years. With stronger mobilisation and better structuring of its research potential and with a sustained and renewed national policy including significantly higher financial support, Lebanon could continue to increase its publication output and become an important partner in the region.

Lebanon has the same level of publication output today that Iran and Morocco had in the mid-1990s and Tunisia and Algeria had just a few years ago. With more than 4,000 publications a year (SCI 4,291 in 2006), Iran, in less than 10 years, has become a major scientific power in the region, ranking 8th in Asia after Israel and Singapore. Thanks to significant political support, Morocco became 3rd in Africa in the late 1990s, just after South Africa and Egypt. Due to recent political changes and less support for research, Morocco lost its position to Tunisia (since 2004) where research has become a well-funded national priority, with a R&D budget equal to 1% of GDP since 2004. Algeria, following the same path since 1998, will soon better Morocco. This shows that a position is never conquered forever and that political will and support, rewards and significant budget increases can make a difference in a relatively short period of time.

In the closer Middle East region, Lebanon, which was lagging behind Jordan in the late 1980s and early 1990, overtook Jordan in 2004, while Syria remained a relatively small player throughout the period under review (see Figure 7).

Figure 7: Number of scientific publications (SCI) in Lebanon, Jordan and Syria (1987-2005)



Thomson scientific data, IRD/P.L.Rossi computing

4.3 The most visible institutions

Table 9 confirms that the bulk of Lebanese research activities indexed in international databases is highly concentrated in three universities: the American University of Beirut (AUB), the Lebanese University (UL) and the Saint Joseph University (USJ). These three universities together account for 83.9% of the overall number of publications indexed in PASCAL during the eight years from 1996 to 2003.

It is not surprisingly that the top producer (52% of the number of publications) and the most visible of the three institutions is AUB. This can be explained by a number of reasons. First, AUB is the oldest university in Lebanon and since the earliest years, considered that good teaching and strong research went hand in hand. Second, AUB is the only university with more full-time titular staff than part-time temporary staff. Third, AUB has the biggest research budget in Lebanon and well-organised institutional mechanisms to assist the AUB community in seeking, developing, submitting, and managing sponsored research projects from a variety of funding sources. Fourth, AUB is also keen on supporting newly appointed faculty members, awarding them seed research grants and providing them with laboratory space. Fifth, AUB has fully integrated a "publish or perish" culture. This is far from being the case in the other universities. The two universities just following AUB have publication outputs of less than one-third of the AUB publication output i.e. around 300 each for the eight years in the study period. This is a particularly low score for UL, given its high quality human resources and underlines UL's recurrent structural problems mentioned above. The impact of the institutional innovations introduced after 2001 may not have generated much progress yet.

Furthermore, the number of publications indexed increased significantly between 1996-1999 and 2000-2003 (58%), but this increase was more largely generated by AUB (75%) than by USJ (29%) or UL (18.2%). A number of other universities are progressing substantially, but are entering the scene at a much lower level (LAU, BU, BAU). Progress at Balamand University (established in 1988) is worth noting. A number of other universities have produced a small number of publications but have not been included in the table since their production level was under 10 indexed publications (Notre Dame University produced 8).

Table 9: The top science producers in Lebanon (1996-2003)

Institutions	1996-1999	2000-2003	Total
American University of Beirut (AUB)	347	607	954
Lebanese University (UL)	137	162	299
Saint Joseph University (USJ)	124	160	284
Beirut Hospitals	38	63	101
Lebanese American University (LAU)	21	42	63
CNRS Research Institutes (4)	12	15	27
Balamand University (BU)	3	22	25
Beirut Arab University (BAU)	6	15	21
Others	22	36	58
Total	710	1122	1832

PASCAL/INIST, P.L. Rossi/IRD computing

The score of the public research institutes, whenever visible, is particularly low, e.g. 27 publications are indexed in PASCAL for an 8-year period for the four CNRS research institutes. This, in part, reflects the limited research staff potential of these institutes. Another reason is that their activities, such as surveys, data acquisition and monitoring for local (e.g. ministries) and regional clients, are generally published as reports or in local or regional journals and hence are not indexed in international databases. This is confirmed by a quick review of two publication lists of CNRS scientists in one institute: a large portion of the references are reports, proceedings of conferences, articles published in local (notably Lebanese Science Bulletin and Lebanese Science Journal) or regional journals or other foreign journals not indexed in international databases. There has been a noteworthy tendency over the last three years (2004-2006), however, to publish more in international journals, a period that has not been accommodated in our survey.

Very similar observations could be made for the Lebanese Agricultural Research Institute (LARI) that do not even show up in Table 7. Only seven publications (one for the first period and six for the second one) were authored by LARI scientists in journals indexed by PASCAL between 1996 and 2003. This does not mean that they do not publish. Some of them publish two to four articles a year in well-respected international journals, often co-authored with well-known foreign specialists, but most of these journals (probably because of their low impact) are not indexed in PASCAL or in SCI. To develop a more comprehensive understanding of their publication outputs, it would be worthwhile making an in-depth analysis of their total production, based on their complete publication lists.

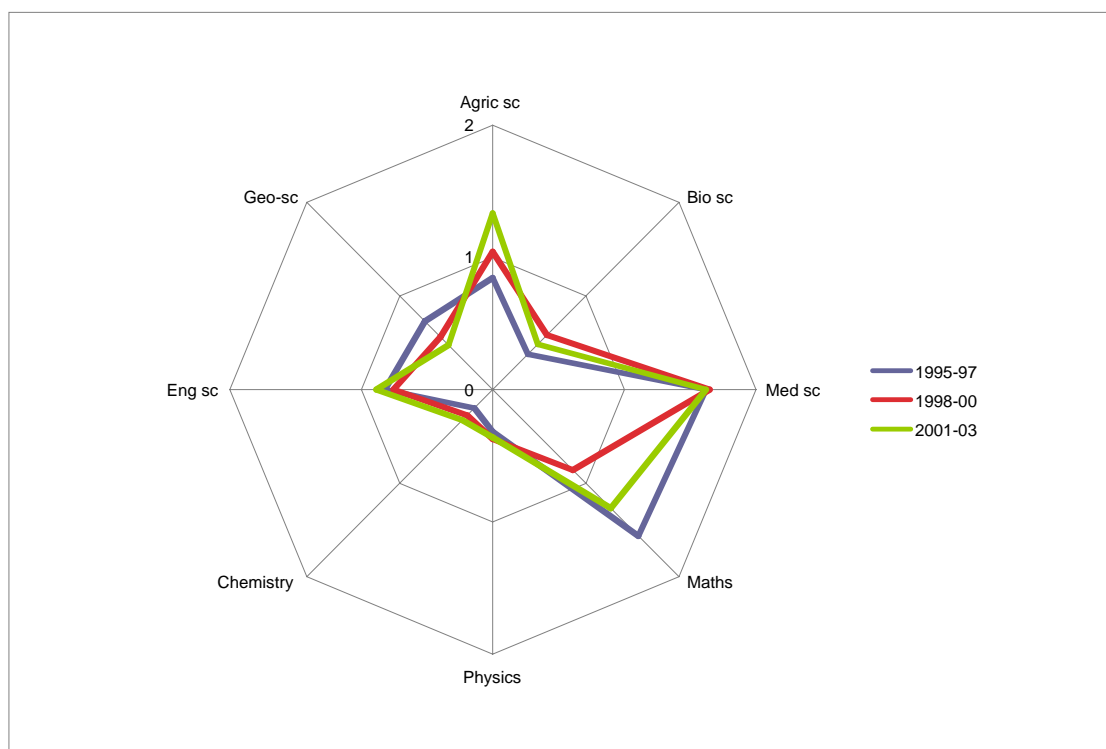
4.4 Specialisation

Beyond global scores, each country may have a particular interest or may specialise in a particular research area or scientific discipline. This could constitute a special asset while marked weaknesses in other disciplines may be detrimental. The degree of specialisation or *specialisation index* can be measured. It is the ratio of the world share of publication in one discipline to the world share of publications in all disciplines. Specialisation exists when the index is above 1, and under-specialisation means that the index is below 1; an index equal to or around 1 is considered neutral.

In order to analyse Lebanese specialisations, we considered the following eight broad scientific areas: Agricultural Sciences, Biological Sciences, Medical Sciences, Physics, Mathematics, Chemistry, Engineering Sciences and Geo-sciences (including the category EOA, Earth-Ocean-Atmosphere- TOA in French).

Lebanon showed a strong and stable specialisation in Medical Sciences for 9 years (1995-2003)³⁵. This was mainly based on the publication outputs of AUB, USJ and to a lesser extent UL and the Beirut hospitals, most of them being connected to a university (see Table 8). Production levels in Medical Sciences rose in all institutions except one, the UL, where the number of indexed publications declined from 108 to 94 between 1996-1999 and 2000-2003. Two other areas of specialisation are Mathematics and to a lesser extent Agricultural Sciences. The index for the Agricultural Sciences has risen regularly over the period of reference, from "under-specialised" to "specialised". This is again mainly thanks to the AUB Faculty of Agriculture.

Figure 8: Specialisation index for Lebanon in 8 disciplines and 3 periods



PASCAL/INIST data, P.L. Rossi/IRD computing

Conversely, Lebanon shows a marked under-specialisation in Chemistry, Physics and the Biological Sciences. The number of publications has increased in all three disciplines (see Table 10) especially in Chemistry and Physics, but the number of indexed articles published every year still remains low particularly in Chemistry. The under-specialisation in these basic sciences may in part explain the slightly low specialisation in the Engineering Sciences (slightly below 1).

³⁵ This result, although valid, may be slightly biased by the fact that one local journal, the Journal of Medical Science (JMS) is indexed by PASCAL. During the period of reference (1995-2003), 148 publications or 12.5% of the output in Medical Sciences was published in the JMS. Yet, although not indexing the latter journal, ISI/SCI gives an even greater and very stable specialisation index to Medical Sciences i.e. 1.75 in 1993, 1.73 in 1999 and 1.78 in 2004.

Table 10: Number of publications by institution and by discipline during the two periods (A=1996-1999; B=2000-2003)

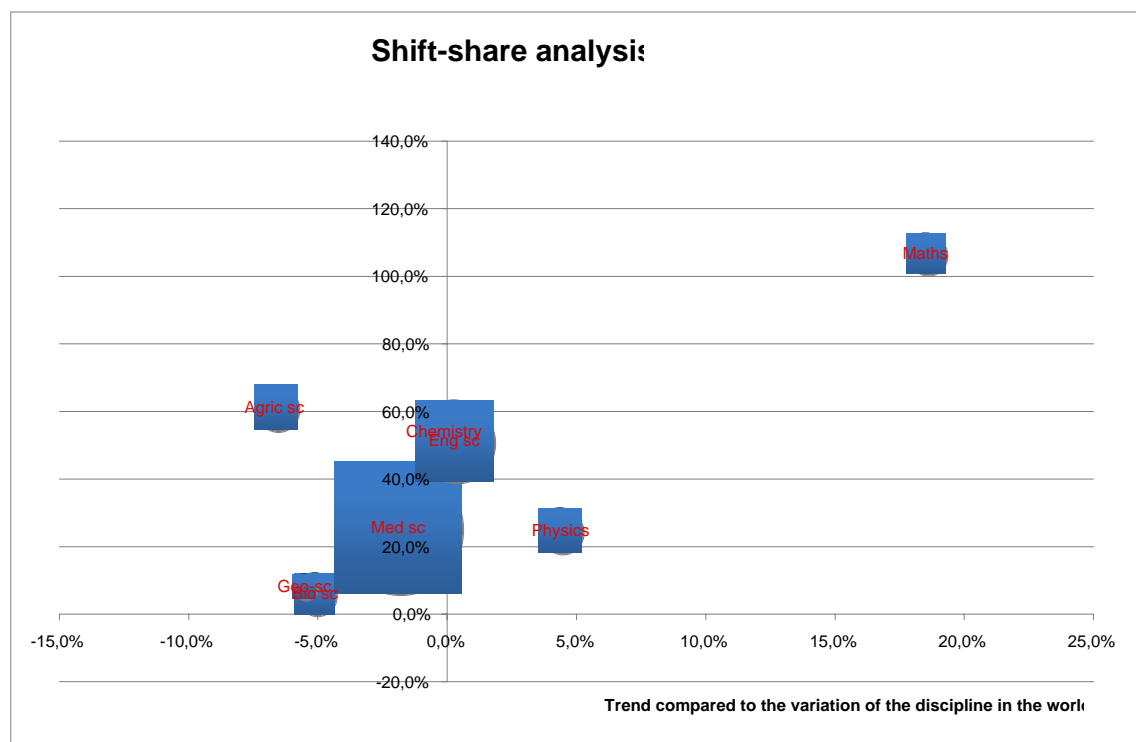
Area	Agric		Biol.		Med.		Math.		Phys.		Chem.		Eng.		EOA	
Period	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
AUB	32	44	29	33	184	343	23	36	22	56	1	7	72	136	11	10
UL	4	9	7	7	108	94	3	6	8	11	1	7	6	34	2	5
USJ	1	4	3	7	116	140		1					2	12	3	2
Hosp.			3	3	37	63										
LAU		3	2		3	10	3	10	5	3		1	14	29	4	
CNRS	2	6	6	2	1	2			2	3	1			1	12	15
BU				3	2	11							1	8		
BAU					2	5		1	1	3		1	3	6		
Lebanon Total	40	68	47	57	426	610	29	57	38	75	3	16	115	229	20	21

PASCAL/INIST, P.L. Rossi/IRD computing

It is also interesting to follow the dynamics of disciplines in Lebanon as compared to the evolution of the same disciplines for the world as a whole. Science in Lebanon is not isolated from the rest of the world and is influenced by the internationalisation of its scientific production. But Lebanese science is also operating in a local context with specific needs and priorities influencing its research agenda. The shift-share analysis proposed below goes on to look at this changing mix of discipline dynamics and at whether a given discipline in Lebanon is shifting toward or away from the world trend for the same discipline over a fixed period of time. In other words, it is an analytical tool used for retrospectively decomposing changes. However, the results presented below and the proposed interpretation should be taken with some degree of caution, given the low number of publications for certain disciplines.

Figure 9 shows that all disciplines in Lebanon progressed more dynamically during the 2001-2003 period than during the 1998-2000 period, with the exception of geo-sciences and biological sciences. One discipline, i.e. mathematics, showed a particularly strong progression in Lebanon (100%), strongly shifting towards, but to a much greater extent, the world's progression of mathematics (20%). Another discipline, i.e. agricultural sciences, shows a strong progression in Lebanon, but a progression that runs counter to the worldwide evolution of the same discipline. Thus, the progress made in the agricultural sciences in Lebanon (mainly at AUB) may be specific to a dynamic taking place in Lebanon.

Figure 9: Shift-share analysis: trends 2001-2003 in comparison with 1998-2000



PASCAL/INIST, IRD/ P.L. Rossi computing

4.4.2 Sub-disciplines and specialisation index for important sub-disciplines

The above results on broad scientific areas can be analysed in greater detail at the level of the sub-disciplines. Looking at the world share of scientific publications at that level may be a way to identify strong sub-disciplines in broad scientific areas that otherwise may be under-represented or, conversely, may pinpoint weak sub-disciplines in areas of marked specialisation in a given country. Here again, the sub-discipline indicators must be interpreted with great care for Lebanon, given the low number of publications at the level of most sub-disciplines.

The indicators presented in Table 9 are based on the analysis of 31 sub-disciplines for publications indexed in SCI. Only the sub-disciplines with 5 publications or more were kept in Table 11. Non-significant results were deleted³⁶. Most of the sub-disciplines in which Lebanon has a world share higher than 0.5‰ are related to medical disciplines: gastroenterology and cardiovascular system (0.72‰), epidemiology and public health (0.84‰), biomedical engineering (0.50‰) and medicine (0.84‰). Moreover, for most sub-disciplines, the world share of publications has increased, following the general trend of Lebanon, which from 0.30‰ in 2001 reaches 0.35‰ in 2004.

³⁶ The indicators for 2004 are provisional. The database for articles published in 2004 is incomplete; about 15% is not included.

Table 11: Lebanon's world share of scientific publications for 31 sub-disciplines

World shares (‰) of scientific publications			
Sub-disciplines	2001	2004	Evolution 2001-2003 (%)
Biochemistry, cellular & molecular biology	0.06	0.15	+151
Microbiology, virology, infectious diseases	0.32	0.36	+15
Genetics, evolution	0.87	1.04	+19
Oncology	0.25	0.45	+78
Gastroenterology, cardiovascular systems	0.69	0.72	+5
Epidemiology, public health	0.70	0.84	+19
Neurosciences, neuropathology	0.19	0.29	+54
Medicine, miscellaneous	0.73	0.87	+20
General & internal medicine	0.20	0.40	+96
Ecology, environment	0.30	0.35	+14
Plant science, agronomy	0.31	0.28	-9
Medical chemistry, pharmacy	0.27	0.40	+52
General & nuclear physics	0.31	0.25	-19
Optics, electronics, signal processing	0.18	0.25	+45
Mechanical engineering, fluid mechanics	0.37	0.48	+29
Computer & information sciences	0.33	0.34	+2
Biomedical engineering	0.59	0.50	-15
Mathematics, statistics	0.46	0.41	-11
Total	0.30	0.35	+16
ISI-Thomson scientific data, OST computing		OST - 2007	

Despite the significant increases in number of publications, very few sub-disciplines show a strong specialisation index (see Table 12). This can be partly explained by the special care taken to elaborate the list of highly specialised sub-disciplines: all sub-disciplines with fewer than 10 publications and a specialisation index under 1.10 were eliminated.

Table 12: Lebanon's specialisation index for important sub-disciplines (listed by 2001 index value)

Lebanon specialisation index				
Sub-disciplines	1993	2001	2004	Evolution 2004/2001 (%)
Medicine, miscellaneous		2.41	2.49	+3
Gastroenterology, cardiovascular systems	3.45	2.28	2.06	-9
Epidemiology, public health	1.80	2.34	2.40	+3
Oncology			1.28	+53
Mechanical engineering, fluid mechanics	1.24	1.24	1.38	+11
Mathematics, statistics		1.54	1.18	-23
ISI-Thomson scientific data, OST computing			OST - 2007	

Only six sub-disciplines, out of which four are related to medical sciences, show a specialisation index equal to or above 1.10. One new medical specialisation (oncology) appears in 2004 that did not appear in 2001 and earlier years.

4.5 Impact

All publications cite other works, and most publications are cited elsewhere. ISI-SCI registers these citations. Thus the number of citations received by a scientific article over a given period of time can be measured. The world share of citations and the impact index can also measure the impact or visibility of science in a given country. The world share of citations is a ratio of all the citations by the world's researchers that relate to the publications of the country under study. The impact index is the ratio, for two successive years, of the mean number of citations per publication by one country to the world mean. Both measure the attraction and the visibility of published articles, and not necessarily their quality³⁷.

Overall, articles published by developing country scientists are less cited than those authored by scientists from leading scientific countries. A number of reasons contribute to this bias, of which most have nothing to do with quality³⁸. But, the impact index may be of some interest, particularly in carrying out comparisons between countries in the less cited periphery.

As shown in Table 13, the world share citation for Lebanon started very low (0.03‰) in 1993. It rose by 380% in nine years and reached 0.13‰ in 2004. The world share citation of all disciplines increased during the same period but certain disciplines that are not a specialisation for Lebanon i.e. physics and biology, increased much more (partly because they were very low at the beginning of the period) than others that are a specialisation in Lebanon, e.g. medical research. Medical research is the discipline that has the highest world share (0.21‰), followed by engineering (0.17‰) and physics (0.13‰).

³⁷ These tools and their possible uses are recurrently discussed in the scientific literature and were extensively criticised. Ultimately the impact index was corrected, see Monastersky, 2005.

³⁸ On this issue of lack of citation and visibility of third world science, see Gaillard, 1989.

Table 13: World share citation of Lebanon for 8 disciplines

Discipline	Lebanon: world share (‰) of 2 year window citations				
	1993	1999	2004	Evolution 2004/1993 (%)	Evolution 2004/1999 (%)
Fundamental biology	0,01	0,06	0,08	+ 1 517	+ 50
Medical research	0,05	0,13	0,21	+ 291	+ 67
Applied biology-ecology	0,01	0,06	0,11	+ 1 064	+ 97
Chemistry	0,02	0,04	0,09	+ 347	+ 140
Physics	0,01	0,07	0,13	+ 1 027	+ 72
Astro and Geo-sciences	0,03	0,08	0,08	+ 185	+ 1
Engineering	0,10	0,20	0,17	+ 69	- 14
Mathematics	0,01	0,08	0,07	+ 392	- 15
Total	0,03	0,08	0,13	+ 380	+ 62

Thomson Scientific data, OST computing

OST - 2007

The impact index for Lebanon in 8 disciplines increased during the same period from 0.27 in 1993 to 0.37 in 2004 (see Table 14). However, the number of publications in each discipline being low, the specific impact index for each discipline may not always be significant. When the number of publications was below 20, the corresponding indicator was marked in grey in Table 12, indicating the probability of its being non-significant.

Table 14: Relative impact index for Lebanon in 8 disciplines

Discipline	Lebanon: relative impact index				
	1993	1999	2004	Evolution 2004/1993 (%)	Evolution 2004/1999 (%)
Fundamental biology	0,16	0,38	0,35	ns	- 6
Medical research	0,31	0,31	0,34	+ 9	+ 7
Applied biology-ecology	0,11	0,39	0,56	ns	ns
Chemistry	0,52	0,78	0,84	ns	ns
Physics	0,21	0,79	0,89	ns	ns
Astro and Geo-sciences	0,52	0,45	0,25	ns	ns
Engineering	0,71	0,64	0,41	ns	ns
Mathematics	0,10	0,22	0,19	ns	ns
Total	0,27	0,35	0,37	+ 36	+ 7

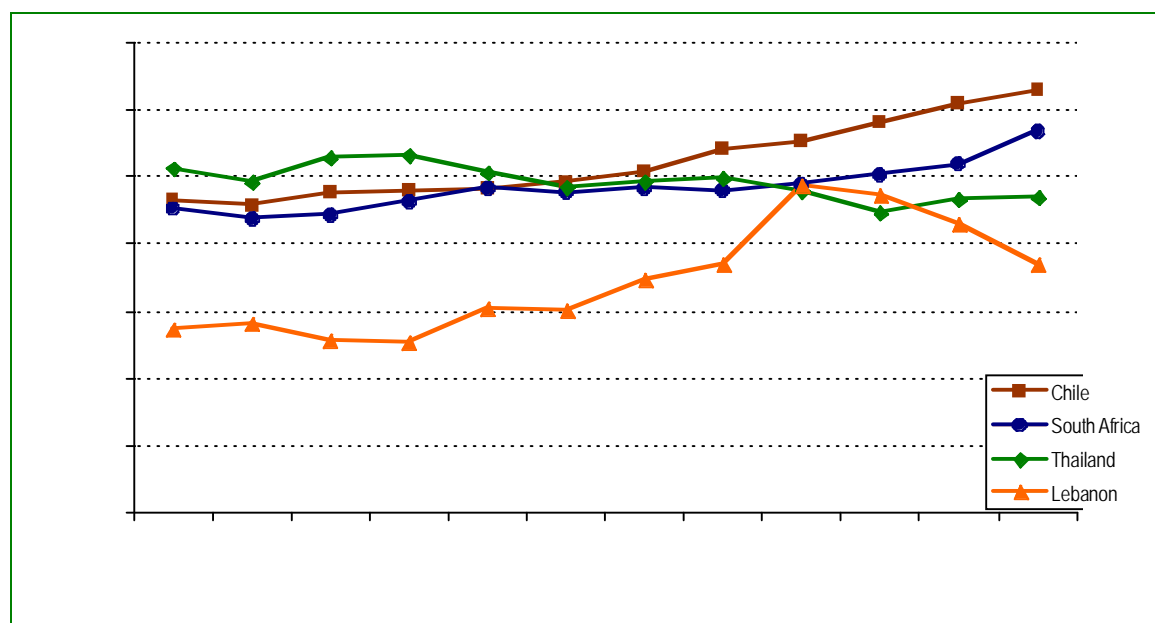
Thomson Scientific data, OST computing

OST - 2007

For the whole study period and the 8 disciplines, the trend was positive: the impact index is higher in 2004 than in 1993 or in 1999. Here again the impact index for medical research (Lebanese strongest specialisation) although growing slightly, is slightly below the average (0.34 in 2004), while engineering (0.41) is above.

Although it may look encouraging to note that the overall impact index for Lebanon is well above that of other countries in the region (most Estime countries have an impact index between 0.20 and 0.30), and that the impact index for Lebanon in 2001 even reached a peak of close to 0.5 (equivalent to South Africa and Thailand), one should be very careful with the interpretation. This peak was mainly due to a very small number of articles co-published with a large number of foreign authors in high impact journals. The most cited article (149 times cited) is an article published in Science in 2001 by a USJ scientist from the Faculty of Medicine together with 16 foreign co-authors. Since 2001 there has been a slight downturn in the Lebanese impact index (see Figure 10).

Figure 10: Evolution of the impact index in scientific publications for Lebanon; comparison with Thailand, Chile and South Africa



4.6 International Cooperation: recent trends and main partners

International co-operative activities in science can take on different formal and less formal forms, e.g. the mobility of students and researchers, the reading and exchange of papers, personal correspondence, the participation in collaborative projects, and the co-publication of scientific papers. Some forms are easier to measure than others. For our purpose we are interested in the level of co-operative activities, as expressed by the number of international co-publications (scientific articles co-signed with foreign authors). The number of international co-publications as a percentage of a given country's scientific publications is, in part, a measure of the degree of the internationalisation of its scientific production.

In response to the growing complexity of science, the ease of face-to-face contact, the Internet, and government incentives, S&T activities are being conducted in an increasingly international manner. In 2003, for instance, about 20% of the world's scientific and technical articles had authors from two or more countries, compared with 8% in 1988. One-quarter of articles with U.S. authors have one or more non-U.S co-authors; the percentage is similar for Japan, China, and the Asia-8³⁹ (NSF, 2006). The higher EU-15 level (35% in 2003) partly reflects the EU's emphasis on collaboration among the member countries as well as the relatively small science base of some EU members. Other countries' high levels of collaboration (close to 45% in 2003) reflect science establishments that may be small (e.g. developing nations) or that may be in the process of rebuilding (e.g. Eastern European countries).

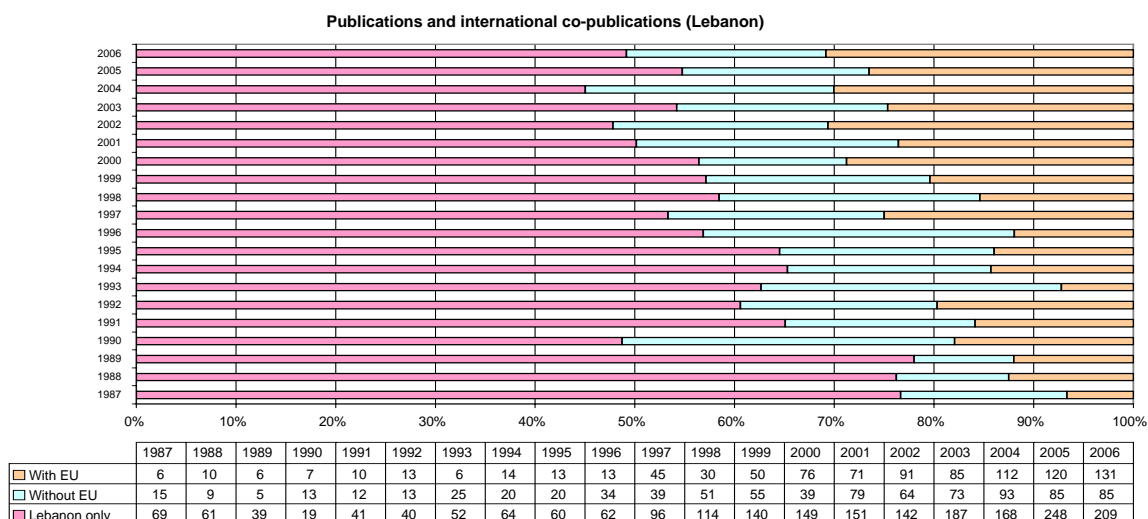
³⁹

Asia-8 is composed of South Korea, India, Indonesia, Malaysia, Philippines, Singapore, Taiwan, and Thailand.

4.6.1 *A relatively high internationalisation of scientific production in Lebanon*

The current ratio of the international co-publications to the total number of publications in Lebanon is slightly above the average level for “other countries” mentioned above (see Figure 11).

Figure 11: Relative share of publications and international co-publications in Lebanon (1987-2006)



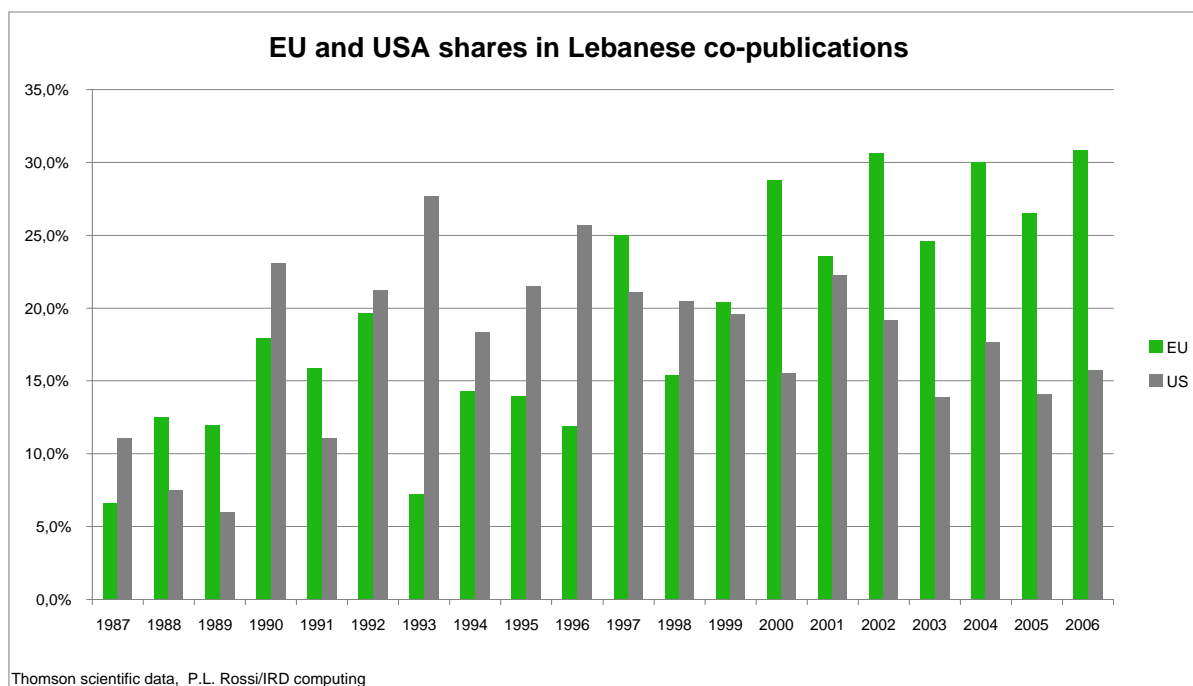
Thomson scientific data, P.L. Rossi/IRD computing

The internationalisation of Lebanese scientific production has decreased significantly, the high being 75% in the late 1980s, the last years of the civil war when international collaboration was essential to survival (see Figure 8) to around 50% today. In 2004, medical research was the discipline that had the lowest percentage of international co-publications (38.6%); chemistry (68.2%) and physics (72.6%) had the highest. The share of international co-publications highlights the increasing participation of Europe (from around 10% in the late 1980s to slightly above 30% in 2006)

4.6.2 *Two main international partners: EU (mainly France) and USA*

In 2006, the most important partner in Europe, by far, was France (around 20%) followed by UK (4.9%), Italy (4.7%), Germany (2.6%) and Belgium (2.1%) in 2006. The share of USA has decreased from a high 27.7% in 1993 to approximately 15% during the last two years (see Figure 12).

Figure 12: The relative share of Europe and USA in Lebanese co-publications



Canada is also a significant partner, comparable to UK and Italy. It should also be noted that Lebanese scientists also co-publish with regional partners such as Bahrain, Saudi Arabia, and Egypt, but at a much less significant level.

5. Conclusion

Despite all sorts of constraints, in particular the civil war of the 1970s and 1980s and the most recent conflict that ended in August 2006, the development of S&T activities in Lebanon has been relatively dynamic over the last 15 years. Although still modest, Lebanon has significantly increased its publication output in the recent past, and the number of publications indexed in international databases registered an almost fivefold increase between 1995 and 2005. Lebanese research capacity and activity are concentrated in three universities, the top and most visible science producer being the American University of Beirut (AUB). Lebanon's scientific production is also highly specialised in medical sciences. Apart from the fact that AUB is the oldest university in Lebanon, its success is mainly due to an enabling research environment discussed in detail in this report. Two other universities play a very significant role: the Lebanese University (UL) and the Saint-Joseph University (USJ). The UL has, by far, the greatest human potential of the three. It is the largest and the only public university in Lebanon, but it is confronted with a number of lingering structural problems that prevent its staff from engaging more actively in research and performing more satisfactorily. These problems have been recognised and a number of well-targeted actions have been proposed. Most of them have not yet been fully implemented.

The contribution of the national research institutes, although tangible, is more modest and much less visible. First, they are younger than Lebanon's first universities. Second, they have a very limited research potential and no serious succession plan to replace the many permanent staff who will soon reach retirement age. Third, their budgets, largely allocated by the Lebanese government, often fluctuate and are rarely disbursed in full. Fourth, they devote an important part of their time to non-research activities, e.g. extension and other services, data acquisition and monitoring, training and teaching, etc. Yet, there has been a noteworthy tendency over the last three years (2004-2006) for research staff in national research institutes to publish more in international journals. During the interviews, several Lebanese researchers in the basic sciences said that one of the most conducive and enabling research environments was the laboratories of the CNRS research institutes when working together with university staff on. This strongly supports the argument favouring the operationalisation of the recently launched CNRS Associated Research Units (URA) programme.

With regard to the national S&T policy framework, during the past several years the CNRS has been very instrumental in initiating a new policy for science, technology and innovation (STIP). CNRS has used this policy to develop and implement a number of integrated action programmes aimed at strengthening, facilitating and promoting research activities throughout the country. Some of them, such as the CNRS Grant Research Programme (GRP) and the PhD Fellowship programme, have been running for several years and have produced tangible results, others, younger ones, such as the CNRS Associated Research Units (URA) were launched during the study period. We believe that CNRS should refocus its mandate on two main core functions: facilitation (as above) and advice.

The implementation of these integrated action programmes also brings out potential weaknesses of and opportunities for the Lebanese Scientific, Technological and Innovation (STI) system. On the one hand, statistics on the outcome of the RGP over the last seven years (2000-2006) confirm the supremacy of AUB, by far the top recipient (42.3% of the projects and 47.8% of the funds). Lessons should be learned from AUB's success. On the other hand, the response to this research grant scheme, after reaching a peak of 156 projects submitted in 2005, has shown a tangible decline during the last two years. The same trend has also been observed with the research grant scheme managed by the UL. Although the reasons for this decline still need to be interpreted, it is clear that the potential of Lebanese researchers actively involved in research activities on a permanent and sustainable basis remains very limited in comparison to the theoretical full potential. Although both figures still need to be confirmed, it is important to remember that more than 90% of the teaching staff in the Lebanese universities probably do not conduct any research at all. This means that there is a vast reservoir of fragmented and dispersed human resources, particularly in the higher education system, just waiting to be tapped. Doing this would require an even more dynamic policy at the national level and at the level of each institution that wants to create a more enabling and rewarding environment for research. It would also require better structured and stronger – sometimes inter-institutional – research teams as well as laboratories with a critical mass of researchers, PhD students and technical staff. Research as a function must also be made more professional and given greater recognition.

This study also points to the paucity of reliable statistical information on STI activities and the lack of a central institutional mechanism to collect such information. As mentioned earlier, more studies are needed, including a special comprehensive survey to measure national capacities and efforts to confirm, invalidate, and/or complement the preliminary STI indicators presented in this report. A proposal has been made to create an STI Observatory, under the auspices of CNRS at least during the creation and development phase, with support from the United Nations Economic and Social Commission for Western Asia (ESCWA) and possibly other partners. To be successful, this observatory should involve and rally all the research and higher education institutions (public and private) presented in this report as well as the private enterprises and NGOs currently involved in research. For this to happen, the observatory should be established on an inter-institutional basis and, eventually, be granted an autonomous status.

The bibliometric studies (see Part 4, Lebanon's publication figures) and the interviews brought out the low visibility of scientific publications, particularly in the research institutes. The result is that these scientific publications may not be adequately considered when evaluating Lebanon's publication output. To develop a more comprehensive understanding of the subject requires a deeper analysis and a study of the Lebanese scientists' total production, based on their complete publication lists. A methodology for such a study is proposed (see Footnote 33).

Finally, the Lebanese people are highly mobile. An estimated 9 million Lebanese people, (figures vary between a low 4 million and a high 15 million) are living outside their country. International migration is affecting all categories of people, including and in particular students and high-skill workers. To get a PhD degree, most Lebanese students have to go abroad, and many do not return home after graduating. Although we do not have precise information on the rate of return, we know that Lebanese people in the diaspora are better educated than in Lebanon (Kasparian, 2003). Given the above figures and information, we can realistically assume that the number of expatriate Lebanese scientists is at least equal to the number working in Lebanon. Although the "Lebanese scientific diaspora" cannot make up for the shortcomings and weaknesses of Lebanon's national scientific community, some people see the "remote mobilisation" of Lebanese scientists and technologists all over the world as a source of great benefit for the home country, e.g. access to scientific information and expertise through extensive social, technical and professional networks, increased training opportunities, and the development of collaborative projects between expatriate and home-based scientists. The idea is attractive but, considering the complexity of the Lebanese society, needs to be approached with circumspection. However simple and enticing it may seem, members of the diaspora may not be easy to enrol. For this approach to be successful, a number of difficult steps must be taken, the first one being the creation of a database of highly qualified nationals living abroad (Gaillard and Gaillard, 1997 and 2003). This task could be one more to assign to the impending STI Observatory.

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List of acronyms

ACSAD:	Arab Center for the Studies of Arid Zones and Dry Lands
ALESCO:	The Arab League Educational, Cultural, and Scientific Organization
ALI:	Association of Lebanese Industrialists
AUB:	American University of Beirut
AUPELF:	Association des universités partiellement ou entièrement de langue française
BAU:	Beirut Arab University
BGR:	Federal Institute for Geosciences and Natural Resources (Germany)
BU:	Balamand University
CAS:	Central Administration for Statistics
CEDRE:	Coopération pour l'Evaluation et le Développement de la Recherche
CERD:	Centre for Educational Research and Development
CEREGE:	Centre Européen de Recherche et d'Enseignement des Géosciences de l'Environnement
CERMOC:	Centre d'études et de recherches sur le Moyen-Orient Contemporain
CLEA:	Centre Libanais d'Energie Atomique (Lebanese Atomic Energy Commission)
CIHEAM:	Centre International des Hautes Etudes Agronomiques Méditerranéennes (International Center for Advanced Mediterranean Agronomic Studies)
CNRSL:	Conseil National de Recherche Scientifique Libanais (National Council for Scientific Research – Lebanon see NCSR below)
CRDP:	Center for Educational Research and Development
CRS:	Center for Remote Sensing
DASR:	Department of Agricultural Scientific Research
ELCIM:	Euro-Lebanese Center for Industrial Modernization
EMSC:	Euro-Mediterranean Seismological Centre
ESCWA:	United Nations Economic and Social Commission for Western Asia
ESTIME:	Evaluation of Science, Technology and Innovation capabilities in MEiterranean countries
FAO:	Food and Agriculture Organization
FTE:	Full-Time Equivalent
GEF:	Global Environment Facility
GIS:	Geographic Information System
GRAL:	Geophysical Arrays of Lebanon
GTZ:	Gesellschaft für technische Zusammenarbeit (German Technical Cooperation for Development)
IAEA:	International Atomic Energy Agency
ICARDA:	International Center for Agricultural Research in the Dry Areas
IDRAC:	Institute for Development, Research and Applied Care
IDRC:	International Development Research Center (Canada)
IFPO:	Institut Français du Proche Orient
IFREMER:	Institut français de recherche pour l'exploitation de la mer (French research institute for exploitation of the sea)
INIST:	Institut de l'Information Scientifique et Technique (France)

INRA:	Institut National de la Recherche Agronomique (France)
IPGP:	Institut de Physique du Globe de Paris
IRD:	Institut de Recherche pour le Développement
IRI:	Industrial Research Institute
LAEC:	Lebanese Atomic Energy Commission
LAES:	Lebanese Association for Educational Studies
LARI:	Lebanese Agricultural Research Institute
LAU:	Lebanese American University (LAU)
LCPS:	Lebanese Centre for Policy Studies
LGIT/Grenoble:	Laboratoire de Géophysique Interne et de Tectonophysique
LIBNOR:	Lebanese Standards Institution
LIRA:	Lebanese Industrial Research Association
LIU:	Lebanese International University
LSI:	Lebanese Standards Institution
LSJ:	Lebanese Science Journal
MEDPOL:	Mediterranean Pollution Monitoring Programme
MEES:	Ministère de l'Enseignement et de l'Enseignement Supérieur (Ministry of Education and Higher Education)
MOA:	Ministry of Agriculture
MP:	Mediterranean Partner (country)
MPP:	Medical Practice Plan
MUT:	Al-Manar University
NCGR:	National Centre for Geophysical Research
NCMS:	National Centre for Marine Sciences
NCSR:	National Council for Scientific Research
NGO:	Non-Governmental Organization
NDU:	Notre Dame de Louaizeh University
NSF:	National Science Foundation
NYSED:	New York State Education Department
OECD:	Organisation for Economic Co-operation and Development
OGC:	Office of Grants and Contracts
RELEMR:	Reduction of Earthquake Losses in the Eastern Mediterranean Region
RGP:	Research Grant Programme
SCI:	Science Citation Index
SIDA:	Swedish International Development Organization
SME:	Small and medium enterprises
SPC:	Syrian Protestant College
STI:	Science, Technology & Innovation
STIP:	Science, Technology & Innovation Policy
SWOT:	Strengths, Weaknesses, Opportunities, Threats

UL: Université Libanaise (Lebanese University)
UN: United Nations
UNDP: United Nations Development Programme
UNEP: United Nations Environment Programme
UNESCO: United Nations Educational, Scientific and Cultural Organization
UNIDO: United Nations Industrial Development Organization
UPA: Université des Pères Antonins (Antonine University)
USEK: Saint Esprit de Kaslik University
USJ: Université Saint-Joseph