

Research in context : scientific production and researchers' experience in Jordan

Pénélope Larzillière

► **To cite this version:**

Pénélope Larzillière. Research in context: scientific production and researchers' experience in Jordan. Science Technology and Society, SAGE Publications, 2010, 15 (2), pp.309-338. <10.1177/097172181001500206>. <ird-00654274>

HAL Id: ird-00654274

<http://hal.ird.fr/ird-00654274>

Submitted on 21 Dec 2011

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

Research in Context

Scientific Production and Researchers' Experience in Jordan

Pénélope Larzillière*

Summary

Researching in Jordan is university-driven as in Lebanon. It is historically based on three public universities: Jordan University, Jordan University for Science and Technology and Yarmouk University. However, while recent development has seen the steady decline of scientific output at Yarmouk University, the more recently established public Hashemite University has increased its scientific output –particularly through its specialization in environmental sciences. Even if the national scientific authorities work more through incentives rather than development plans, an overlap between national priorities and research specializations can be observed. Indeed engineering, medicine and chemistry are especially important in Jordan, mainly through partnership with the USA or with regards chemistry, Germany. Gulf countries are a second important pole which attracts Jordanian professors to teaching, because of the high salaries they receive. However, it is too early to consider it a brain drain since Jordanian professors only stay for one or two years before going back to Jordan. Moreover the Jordanian official policy actively promotes the exportation of skilled staff to help build its economy. However this situation may change if Gulf countries succeed in keeping this skilled workforce.

The social and political context of research in Jordan is made up of the national system of research, with its institutions and its policies, plus the complex web of constraints, which ranges from the very local to the international, directly experienced by researchers,. As we will show in this article, among the different constraints, the international agendas of the donor organisations strongly influence and format scientific production. Indeed, foreign aid has always been the main source of funding for the Hashemite regime. Jordan, with a population of 5.4 million, is categorised as a lower – middle income country¹ whose economy is constrained by limited arable land, water and energy resources. At its creation in 1921 (under British Mandate) and then its independence in 1946, British financial support was essential for Jordan. In the seventies, Arab financial assistance became central. ‘When it declined in the second half of the 1980s, Jordan resorted to borrowing to maintain spending

*Pénélope Larzillière is a senior researcher at the Institut de Recherche pour le Développement (IRD), UMR CEPED (University Paris 5 Paris Descartes - Ined – IRD), 19 rue Jacob, 75006 Paris.

E.mail : penelope.larzilliere@ird.fr

I thank Rigas Arvanitis, Jacques Gaillard, Venni Krishna and Roland Waast for their helpful comments on the first draft.

levels and had then to open negotiations with the IMF about its debt service' (Wils, 1998, p 100). Until now, foreign aid has played a very important role in the Jordanian economy. In 1995 and 1996, Jordan received the highest amount of development aid per capita world wide. Jordan has been perceived as a key-player within the Middle-East and 'Jordanian policy makers have used the country's geo-strategy as a political asset to overcome its shortage of natural resources' (Wils, 1998, p 101). The consequence of this permanent support has been the constitution of a rentier (rent-based) economy.

Any analysis of the Jordanian context for research has to take into account the way the country has managed the international agendas on development and the security issues. In the first part of this article, we will examine the political insistence on the importance of research and the need to develop research institutions, both to address international demands and to invest on high skilled staff as an alternative to other kinds of resources. The bibliometric analysis of the Jordanian scientific production reflects the State's priorities, its top disciplines and the importance of the United States in the scientific system (part 1.2.). The second part of the article, based on a series of extensive interviews with researchers², identifies the experience of the researchers, which combines three levels of constraints: local, national and international³. These constraints are in some respects translated into contradictory injunctions (2). The researchers' orientation towards expertise seems, however, to respond to trends common to the three levels (part 2.4.).

The results presented here are based on qualitative and quantitative data, collected during the ESTIME project between 2004/2008, and the various reports produced⁴.

¹ GDP per capita (PPP USD): 5530 in 2005. Human Development Index: 0, 733 in 2005. Source: UNDP Human Development Report.

² Forty-six qualitative interviews (twenty-nine in social sciences) realised by Nedal M. Alouran, Abdel Hakim Al-Husban and myself.

³ These constraints or tensions are shared by many third world scientists (Gaillard, 1991; Gaillard, Krishna and Waast, 1997).

⁴ The project ESTIME « Evaluation of Scientific, Technology and Innovation Capabilities in MEditerranean countries was funded by European Commission, DG Research, sixth framework Program and coordinated by Rigas Arvanitis (IRD). www.estimate.ird.fr. Concerning Jordan, the country report (Larzillière, 2007) has been based on the following background reports:

1/ Science & Technology and Innovation Profile of Jordan, authored by Dr. Khaled Elshuraydeh and Eng. Isam Mustafa/Project Manager, with the assistance of Dr. Mohammad Al Majali, Eng. Majeda Al Assaf, Eng. Falak Sarraf, Mr. Omar Hamarneh, all from the Higher Council for Science and Technology

2/ Scientific Production, report authored by Françoise Laville and Jean Thèves (Observatoire des Sciences et des Technologies); and the report of Pier Luigi Rossi and Roland Waast (Institut de Recherche pour le Développement).

3/ Research in the Exact Sciences in Jordan, intermediate report by Nedal M. Alouran

4/ Research in Social Sciences in Jordan, report by Abdelhakim al Husban (Yarmouk University).

1. Is there something like a national system of research in Jordan?

Concerning the general indicators on scientific research, Jordan is in the lower average category but slightly above the average of Arab countries (0.2 per cent), with an expenditure on scientific research of 0.34 per cent of the GDP in 2003. In 2006, 6.6 out of 675 million of dollars of foreign assistance (grants and soft loans) were especially dedicated to S&T. (Jordanian Ministry of Planning, foreign assistance by sectors). See Table 1 and 2.

1.1. The Jordanian S&T official policy

There was no post-secondary education in Jordan before the unification with the West Bank in 1950. Then, institutes were established which focused on the formation of teachers for the growing number of new schools in the country. The percentage of illiterates was still of 67 per cent in 1961. The first university was funded in Amman in 1962, however, numerous Jordanians had already graduated in universities from neighboring countries. Since the 1960s, Jordan has made an effort to develop its national science and technology capabilities. It has been part of the general view that have linked science and development in the region and has been generally promoted by the elites and the monarchy. Elisabeth Longuenesse mentions a 'scientist ideology' especially supported by the engineers through their professional association. In an editorial of their journal published in 1974, it was written: 'Power of nations is not anymore in the number of inhabitants only. At time of science and technology, they exist only through the invention of engineers and technicians, men of science and thinking' (quoted in Longuenesse, 2000: 28). That particular link still exists as the HCST always includes the engineers in its statistics about research staff and the professional associations insist on their promotion of knowledge (Larzillière, 2010). In 1961, the Scientific Research Council was established, which aimed at a more efficient use of S&T in development plans. It was replaced in 1977 by the Directorate of Science and Technology directly integrated to the Ministry of Planning. It prepared the S&T policies and again linked scientific activities and developmental objectives. In 1978, the official 'Jordan's Science and Technology Policy Conference' recommended to orientate the scientific and technological policy towards the development needs. Past development plans have aimed at integrating more technology in the economy, the productive and service sectors, and at upgrading the country's scientific capacity. Jordan's capability to undertake scientific research has been enhanced with the creation of private and public scientific institutions. All the governmental documents insist on the importance and value of applied research and innovation for the country. In 1991, the

national charter⁵ included a focus on S&T with an emphasis on an advanced system of education (especially for science and mathematics) and mentioned again the link between research and the ‘developmental needs of Jordan’. In the national agenda (2006-2015)⁶, scientific research is presented as one of the eight main themes for the development of the country and the necessity for a system of innovation promoted. The S&T policy for Jordan focuses on the establishment of channels allowing better access to international sources for scientific and technological institutions in Jordan, an increase in the number and qualifications of researchers and more research-technology transfers. The strategy to achieve these goals is officially defined as follows (Elshuraydeh and Mustafa , 2006:82):

- ‘Endorsing S&T as one main input into all national development plans and programmes.
- The optimal and sustainable use of the natural resources in sectors considered vital to development (water, energy, agriculture, health, environment), and others where Jordan possesses competitive advantage (pharmaceuticals, mineral resources, tourism) through proper applications of advanced technologies).
- Enhancing partnership and synergies between S&T community and stakeholders in the public and private sectors.
- Employing suitable national resources towards the achievement of the goals of the national science and technology policy.’)

The executive programme 2007-2009⁷ (Ministry of Planning and International Cooperation) insists again on technology transfer and especially on linking the objectives of universities and research centers with those of the industrial sectors and enhancing the cooperation between the various research centres (p 25).

Based on this consistent recommendation, and on the need stemmed from the increased scientific activity in Jordan, it was decided to institutionalise scientific and technological activities under a national umbrella that would set science and technology policy, strategies, plans and programs. A national committee was established, around twenty years ago, and entrusted with the task to develop a framework for a national organisation that would cater for S&T activities in Jordan. The Higher Council for Science and Technology (HCST) was established in 1987 to build a national science and technology base. It is presided over by

⁵ Issued by a sixty-member royal commission appointed by King Hussein. For an English version of it, see www.kinghussein.gov.jo/charter-national.html

⁶ Issued in 2005 by a twenty-six-member committee formed by a royal decree. For an English version of it, see www.nationalagenda.jo/portals/englishbooklet.pdf

Prince el Hassan Bin Talal and its council includes ministers, the commander in chief of the Jordanian Armed Forces, the president of the Royal Scientific Society (RSS)⁸, the presidents of Amman chamber of commerce and industry and the General Secretary of the HCST. It is provided by an independent budget 94 per cent of which derives from the government (budget 2006: 2, 1 million de USD⁹). It has affiliated research centers (whose size and importance cannot be compared with those of the RSS however) and specific units. See figure 1, table 3 and 4.

If the role of the HCST is to help to implement the Jordanian S&T policy and strategy, Jordan is not a planning based economy in the strict sense of the expression. The Ministry of Planning's national agenda defines sectors that are to benefit primarily from public finances. The HCST works through incentives (also financial), services and acts as a facilitator. It also insists on its role as networker and launches surveys or evaluations in R&D. As Roland Waast analyses it, Jordan is therefore in the second model of a system of research in Arab countries, the non-centralised one, where 'there are any numbers of initiatives around small and scattered projects rather than programmes and they are not coordinated'. The concentration is on R&D rather than S&T (Waast, 2008: 26 and 29). There is no real system of research and it is difficult to develop a national research strategy, despite the numerous official declarations, as the analysis of the main organs of research will further show.

1.2. The Importance of Public Universities

Research is present in three main sectors: universities, NGOs and private centers, and research centers directly linked to the Higher Council for Sciences. Most scientific research is carried out by the public universities¹⁰. The contribution of the commercial private sector is not visible in the field of scientific research, neither directly performing it, nor providing financial support to research activities. Few initiatives have been taken to furnish some units and offices or to renovate some buildings. Jordan has twelve private and ten public universities. (see table 5) The total number of tertiary teaching staff including all academic ranks in public and private Jordanian universities is 9,094. The total number of all enrolled students including

⁷ Available on www.mop.gov.jo

⁸ An important organ in R&D with a special status, see below.

⁹ 1 Jordanian Dinar: 1, 4 USD (October 2008)

¹⁰ A funding that can be generalised to the whole Arab region (Nour, 2005), even if the study of Samia Nour does not include Jordan.

all degrees is 231,657 students (academic year 2007/2008, see figure 2 and 3). The tertiary enrolment was 39 per cent in 2006, above the regional average of 22 per cent¹¹.

The main universities in terms of scientific production are the Jordan University funded in 1962 in Amman, the Jordan University for Science and Technology (JUST) in 1986 in Irbid, one of the main technological universities in the Arab world, and the Hashemite University funded in 1995. The ranking is not different if expenditures on research and development are considered: Jordan University still spends the highest budget on R&D direct spending (laboratory equipment included) with an amount of more than 7 millions USD, followed by JUST (nearly 3.9 millions USD.) and the Hashemite University (3.6 millions USD). In 1990, the first private university, Amman Private University, was established in Amman. However, private universities, which are new, market-oriented and of a lower teaching level (Augé, 1997), hardly carry out any research activities. Even if scarce, the budget for research in public universities is still above the very low amount dedicated to research in private universities (based on the results of the HCST study).

In the 1990s, when the martial laws were lifted, the number of non governmental organisations in Jordan markedly increased. Research agenda also changed. In social sciences, topics concerning human rights, democracy and liberal economy have been favoured (Al-Husban, 2007: 15). Abdel Hakim Al-Husban underlines that ‘most of these nongovernmental organisations are usually supervised either directly by ex or current officials or members of the royal family or indirectly through joint projects between these organisations and the Jordanian state agencies. The establishment of any society or organisation requires certain strict procedures controlled by the Ministry of Interior and its agencies including the security department.’ (Al-Husban, 2007: 15) Therefore, as far as NGOs and private research centers are concerned, they can only be partly considered as independent from the regime as one specificity of Jordan is the prevalence of ‘Royal NGOs’. This is for example the case of the Royal Scientific Society, funded in 1970, the most important ‘private’ institution for research, with about 670 employees. It is close to the main scientific institutions such as the University of Jordan or the HCST (budget 2006: 13 580 000 USD, 97 per cent private). It mainly concentrates on applied research and providing technical services to the public and private sector. The RSS has the following research/technical centres/Departments: Information Technology Centre, Electronic Services and Training Centre, Mechanical Design and Technology Centre, Building Research Centre, Environment Research Centre, Quality

¹¹ Source UNESCO Institute for Statistics

Assurance Department, Marketing, information and International Relations Department, Technology Transfer Centre and Enterprise Support & Conformity Assessment Department.

In addition to non-governmental organisations, the number of private centers which usually register themselves as commercial companies has increased, especially in social sciences (IFPO, 2007: 23), but only part of them has real activities (a lot of them were created by only one person to make one-off consultancy). The lifting of the martial laws has allowed this growth which follows the growing funding, national and international, for consultancy concerning the Jordanian society (Al Husban, 2007: 16). This international capital influx is considered by the political system in Jordan as supportive rather than threatening its decision-making.

1.3. Gulf countries as economic center of attraction. Evolution from the 1980s to 2009.

Apart from the influence of Western capital, international donors and development agencies in Jordan, the Gulf countries represent an important second pole of influence for Jordan. They can be considered as both an asset and a handicap for the country. Gulf countries need skilled staff, among them teachers and engineers, and it has been part of the economic strategy of Jordan to train people to go to work there. The resources they brought back to Jordan have been even greater for the economy than foreign aid ¹². Jordan had also benefited before from the arabisation of Morocco and Algeria which were then searching for Arabic speaking professors. It reached a very high point in Jordan as in the middle of the 1980s, 40 per cent of the working population was outside the country (Samha, 1990: 3 quoted in Bel-Air, 2003: 7). Jordan has been very dependant on external resources and its economy is not a productive one. In Jordan itself, the tertiary sector and the State are the main employers. As Antoine Zahlan puts it there is here a question of economic and technological choices for Jordan and not of a shortage of qualified staff (Zahlan, 1990, pp 120-121). As a consequence Jordan is very sensitive to any crisis affecting the Gulf region. In 1990/91 during the Gulf war the emigration stopped for a while and about 300 000 returnees came back to Jordan (mainly Palestinian ones). Unemployment in Jordan increased, especially targeting qualified people (Longuenesse, 1990: 17). The crisis was not only economic but also political and following the collapse of the rentier system, protest emerges. As an answer to that crisis as soon as it

was possible, massive emigration has started again from 1994 on (towards Gulf countries but also to the United States). As Françoise de Bel-Air shows ‘massive emigration has represented and still represents a strategy for political and social stabilisation, which guarantees the reproduction of power structures’ (2003: 1). Governmental declarations mention the capacity to export human expertise and skilled manpower as one of the resources of Jordan¹³.

Since few years, the academic level of the universities in the Gulf countries has improved and Jordan’s best qualified professors and researchers have gone there in search of higher salaries and better conditions of work. Even if salaries in Jordanian universities are still high compared to the average in the country and to other careers in both public and private sectors, they are below that of salaries in private universities and vastly below those in Gulf countries¹⁴. However, it is difficult to speak here of a real ‘brain drain’ for Jordan because, as mentioned above, it is an economic and political strategy (Cantini 2008, ‘to export protest and brains at the same time’ De Bel-Air, 2003: 21).

Brain drain is also limited because professors leave the Jordanian public universities ‘to make money’ for one or two years and then go back to Jordan. The Jordanian public universities are still more prestigious, and they prefer the social environment of Jordan (specifically concerning the sociability and way of life), usually their family stay in Jordan during those years. Moreover, they are recruited mostly to teach, not to do any research. Further research in the following years should confirm or not the difficulties for Gulf countries in stabilising their foreign University staff. It seems however that this trend is increasing, forcing Jordan to recruit some teachers in Egypt. The latest Jordanian executive program (2007-2009) insists at the same time on facilitating departure of academics (sabbatical leaves etc) and on

¹² In 2008, workers’ remittances reached 3, 1 billion of USD for a GDP of 21 billions. Source: The World Bank, World Development Indicators Database, September 2010.

¹³ See for example www.kinghussein.gov.jo/ressources4.html

¹⁴ All public universities have (more or less) similar scale for salaries which mainly depends of the professional rank of the research staff (assistant professor/researcher, associate/professor). Research staff who works on large-scale projects and get involved in some admin work usually get paid for such extra efforts.

Rate of salaries in the public universities in Jordan

| | |
|---------------------|---------------|
| Lecturer | 840-980 USD |
| Full Lecturer | 980-1260 USD |
| Assistant Professor | 1260-1400 USD |
| Associate Professor | 1540-1820 USD |
| Full Professor | 1960-2240 |

The average salary of some professions and public careers

| Career | Salary |
|--|---------|
| General Doctor working in the Ministry of Health | 560 USD |
| School Teacher in a public school | 336 USD |

maintaining the links with the Jordanian researchers abroad (p 13-14). As Anne-Marie Gaillard and Jacques Gaillard analyse it, a ‘genuine logic of circulation’ (rather than brain drain) may be positive for national research by ‘contributing to the internationalisation of S&T activities in the home countries’. It only works however if the scientists regularly return and a real Diaspora-home country linking exists (Gaillard & Gaillard, 1997: 220-221).

1.4. Scientific Production: between institutionalised laboratories and ‘invisible colleges’¹⁵?

Jordan has ‘almost doubled its participation in the world science during the last decade’ (Waast, 2008: 38) See figure 4 and 5. The bibliometric increase is due firstly to the constant growth of the three main subject areas of specialisation: medicine, engineering and chemistry¹⁶ and secondly to the development of new specialisations in mathematics, environmental sciences and computer sciences (see figure 6 and 7).

The bibliometric analysis of Jordan’s scientific production confirms the centrality of the United States for research in Jordan. It is not only a crucial donor but also the main partner as the analysis of Jordan’s five first partners in terms of scientific publications demonstrates (see figure 8). The United States are by far the first partner of Jordan’s publications, followed on by England and Germany. While Jordanian scientists are co-authoring publications with colleagues from Arab countries (United Arab Emirates, Saudi Arabia etc.), no countries of the Middle-East are significantly visible as scientific partners. Canada is becoming a more prominent scientific partner. By subject areas, the United States are usually the first scientific partner, and occasionally the second one, as for chemistry (first partner: Germany) See Table 7. Interviews with researchers confirm the main role played by Germany in the sector of chemistry. Historically, most researchers in chemistry studied in Germany and have remained in cooperation with research laboratories there. They prefer to register their patents in Germany to be recognised world wide, despite the financial cost. They do not trust the Royal Scientific Society Patents system and find it too local. As far as medical research is concerned the interviews reveal that cooperation with the United States has increased.

Army officer

560 USD (Al Husban, 2006, p 17)

¹⁵ I use the term to emphasise the importance of short networks of interacting scholars from geographically distant research affiliates (Zuccala, 2006:158), indispensable for fulfilling information needs, giving publication opportunities and bringing funding (so not necessarily informal).

¹⁶ Based on the analysis of the SCI data basis in Scimago. If compared to the results in ISI web of science, which aggregates disciplines in a different way, electrical engineering becomes first, before medicine and chemistry. These analyses do not concern social sciences.

These bibliometric results can be compared with those based on the Pascal database (Rossi, Waast, 2007). We can observe almost the same orientation in terms of main disciplines. Indeed a specialisation in energy engineering and pharmacy appears. However the 'Science des Technologies de l'information et de la communication' (STIC) is more prevalent than before, ranked at the first place. The institutional level of analysis (see figure 9) confirms the main role played in research by two public universities: Jordan University and JUST. The Yarmouk University that was at the third place in 2000 is in 2009 at the seventh, because of a slightly decreasing scientific production, especially in its electrical engineering specialty, in a global growth context. The Hashemite University has now taken the third place with a focus on environmental sciences. The national research centers only marginally appear in the data basis, far behind public universities.

Bibliometric results should always be taken cautiously, given that numerous articles are published in so-called 'local journals', in Arabic, and are not registered in these databases, although they are important for the Jordan scientific community. Jordanian research is published at national, regional and international level. On a national scale, there are several local accredited journals mainly published by universities and academic institutions in Jordan. Most of the research that is of significant interest to the community is usually encouraged to be published in such local journals, a common feature in the developing countries. Some researchers however prefer to publish in these journals to save the time usually needed to submit, review and modify the articles in international journals (it is not always a choice as many subjects are considered too 'local' to be published in international mainstream journals). Nevertheless, Jordan's specialisation in energy engineering and chemistry/pharmacy corresponds to the state's main priorities as presented by the national agenda. Moreover, engineering and computer sciences including mathematics constitute 23.7 per cent of total of students and 24.7 per cent of total of faculty- matching the government emphasis on engineering talents (see table 6). According to the government as Jordan lacks natural resources but has qualified staff, its economy should aim at providing services to the Middle East and the Gulf countries. One of Jordan's main goals is to specialise in medical services and to develop state of the art clinics. Unlike the general trend in research in Jordan, the increase of publications on pharmacy is due to private universities and industrial research and not to the three main public universities. Regarding energy engineering, technologies are being developed to exploit low quality oil wells that are now economically viable. It also shows again how much Jordan's economy is oriented towards Gulf countries.

Following these results a double trend could be noticed. On the one hand, the most active researchers in Jordan, mainly located in the three main universities, widely depend on an international network mainly situated in the United States, apart from Germany for chemistry. They create contacts while doing their PhD abroad (almost no PhD programs exist in the country) and depend on their contacts later on. It is not only a question of getting funds for their research. They can also directly apply for funding in international agencies, doing more or less expertise. Their main objectives are trying to stay integrated in the ongoing world wide research, to get access to some instruments and machines they do not have in Jordan, to most recent publications and then to be able to publish in core journals. The most active researchers then appear more as individuals inside their own institution working inside ‘invisible colleges’ (Crane, 1972; Wagner, 2008; Wagner and Leydesdorff, 2005) whose main pole is in the United States. In that context, a second pole represented by the Gulf States does not have exactly the same function. It is more an economic pole as Jordan provides it with services and professors. A usual pattern for researchers is to specialise more actively in the disciplines in greater demand (oil, medicine) and go in the Gulf countries for teaching.

2. Researchers: A triple level of constraints

Research is indeed carried out in Jordan at the crossroad of different levels of agendas and constraints, locally, nationally and internationally. While local constraints come about through the social environment, nationally the administrative directives and governmental policies define the contours of the profession and research priorities. At the international level (and in a western hegemonic context), the agenda of international funding agencies and the criteria for publication in peer-reviewed journals impose a double constraint. These simultaneous and often contradictory agendas produce a web of constraints on the Jordanian researchers and some paradoxical effects.

2.1. The local conditions for research

‘When to do research?!’

Most researchers in Jordan are university teachers at all levels: professors, assistant-professors and associate professors. According to them, in the public universities, they are in a contradictory position as they are evaluated on their publications (the criteria for promotion) but they do not have sufficient time to spend on research because of time-consuming teaching

duties. Indeed, the lack of time for research is among their main worry, often before even the lack of budget. More than the low budget allocated to research in the universities, all researchers mention long, tortuous and opaque procedures that bog down the initiatives and discourage researchers to apply. Researchers in archeology specifically complain on the difficulty to obtain authorisations of the Jordanian Department of Antiquities: ‘I stopped my field research because of the obstacles put by the director of the antiquities department. Criteria for giving the authorisations are purely personal’¹⁷.’ A third time-consuming factor should be taken into account: professors are part of a strong family and tribe network, which conveys obligations as well as it implies the possibility of social support in case it is needed. Many researchers mention these obligations as one of the most time-consuming activities and a drawback for research (Al Husban, 2007: 47). As they detain a position at the university and a title of knowledge (their PhD), they are looked at as a resource for the family and the tribe. It means that they are very frequently approached, to obtain financial assistance for a student, to support relatives into getting a job in administration etc. These visits often take place at the professor’s office in the universities itself. Researchers often complain in the interviews about these expectations and do not feel especially able – or willing – to satisfying them. But they are indeed at an interesting linchpin position that could also explain this interest. Indeed if ‘legitimisation by knowledge and technique is often opposed to power legitimisation by the notability of a person’ (Signoles, 2006: 256), researchers seem to be able to partly combine both, as they detain a good position (and a good salary) in a public administration as well as a legitimate knowledge role. Of course, this situation is more evident when they get promoted at higher administrative levels inside the university.

And how to publish it?

Even if it is difficult for academics to find time and money to do research, they have to publish to get promoted. Promotion is often mentioned as one of the main motivations to publish research. Most of them are however very dissatisfied with the possibilities for publications in Jordan. They mainly target three types of journals. The main ones are the journals of the Jordanian universities in Arabic, with a special mention for *Dirasat* (Jordanian University). Their perceptions are here quite contradictory. Some of them think that publishing in such local journals is an easy way out to avoid the long reviewing process in international journals. However they also complain about the very long delay between

¹⁷ Interview with a professor in archeology, Yarmouk University, May 2006.

submitting and publishing in the local journals, because there are quite few journals if compared to the number of articles accepted. Their data are then not accurate anymore. Concerning the referees in Jordan, academics criticise a too personal system. It is very easy to identify the author of an article, given the very limited size of the scientific community, so that rivalries or sympathies impede or support the publication of an article. For the same reason, it often happens that articles are evaluated by referees from another discipline, what academics regret too.

However a regional scene (including Turkey journals in English) is developing and notably the importance of Kuwait journals (in Arabic) is growing. The concentration on these journals has also for consequence that a great part of the Jordanian production does not appear in international databases. The Jordanian executive program 2007-2009 has however dedicated a specific budget to the internationalisation of Jordanian journals (according to it, 20 per cent of the Jordanian periodicals are currently published internationally) (p 113). Concerning the publications in international journals –including German ones for some disciplines- (social sciences excluded), ‘5 to 10 per cent of the academics, are intensely active in research, authoring half of the production’ (Waast, 2008: 30). This means that the Jordanian production rests on small groups. However as some Jordanian universities are changing their criteria and give less value for promotion to articles published in Arab journals, that could change in the future.

2.2. Coordination or censorship? The influence of the State’s orientations on researchers

As civil servants, professors answer to the State. First, the monarchy economically advocates liberalism but tightly controls political life and elections (parties, first authorised in 1991, have always been under law restrictions). For example, the National Security services can object to a promotion in a university. But political control is mainly affecting research through a kind of self-censorship: sensitive political subjects are rarely addressed. There is also a censorship office which supervises all publications by rule. The government can be criticised but never the monarchy itself. Apart from this, researchers, mainly in natural and exact sciences, consider that they freely choose their research subjects. Some of them have even been asking for more state coordination and cooperation with other countries. However, concerning the agenda for research, a connection can be noted between state priorities and the subjects of research. It might be an indirect connection through financial support for certain

research themes. Better chances of being funded and acknowledged can make researchers choose thematics that have been put forward by the government.

There is also a general trend to highly value 'applied research' and links with firms. It is not only an incitement at the state level but also part of the researchers' discourse. They want their research to have immediate applications, and, as far as social sciences are concerned, to be in close connection with the social agenda. But a paradoxical consequence of the low budget for research is a concentration on 'basic research' or, to be more accurate, on research which does not require laboratory experiments or long field research (being more bibliographical). 'Basic research' is thus considered less expensive, even if no financial remuneration might be expected from it, because the initial investments are lower than those for 'applied research'. The shortage of funding has also consequences on their capacity to obtain up-to-date publications and to keep informed on the latest international developments for research in their disciplines. In turn, this largely influences their own capacity to publish original articles, considered worthwhile publishing outside Jordan. The most internationally integrated researchers get round this difficulty through the help of their foreign colleagues. National scientific societies have also a role here (much less in social sciences) and more specifically the professional associations, with their 'scientific and technical committees'.

2.3. The impact of the international donors' patterns

The influence of international organisations in Jordan is strong. The Jordanian State might be, as we just mentioned, administratively strongly influencing research orientations, but its financial impact is low. Jordan's policy has been to search for international development funding, and to support the role of royal NGOs. Jordanian institutions try to develop the statistical tools required by such institutions and to respond to their criteria. That also has consequences on the research agenda: indirectly through links between governmental priorities and those of these organisations, and directly through the applications of researchers for such funding from external donors. Indeed, as can be observed through the research subjects and projects mentioned by researchers, the thematics, objectives and vocabulary correspond to the expectations of the donors (for example, the extensive use of the 'empowerment' notion, the increase in the number of studies on women rights, child rights, poverty, globalisation etc.). Both agenda and tools used in research are influenced, but it also puts Jordanian researchers in a position of becoming more or less 'informants' on their country, and producing numerous, often unpublished, reports to comply with the needs of these organisations.

2.4. From research to expertise: a new role?

Researchers have financial and social interest in becoming ‘experts’. The relatively new international demand for local experts in social sciences has given new status and opportunities to professors in those fields, if they adapt to the lexicon and methods of international organisations (Romani, 2008: 230). Indeed, social sciences were usually badly classified and the least recognised disciplines in the universities: the marks needed at the ‘tawjihi’ (general secondary examination) to start medical or engineering studies are the highest, while those for humanities are the lowest. But this tendency does not solely concern social sciences: the evolution towards expertise can be considered a general trend. Elisabeth Longuenesse, for example, notes the same evolution for engineers. She associates this trend to a possible disconnection between the participation to the national project and individual careers (2007: 227-229). However it is also a new way of politicisation sometimes. The technical discourse of expertise is not only highly prized by the government; it is also adopted by dissidents (Signoles, 2006: 256). It has been insistently sustained in Jordan by King Abdallah II when talking of economic reforms and the promotion of a ‘new guard’ consisting of experts and businessmen. New actors and organisations invest the field, for example NGOs and human rights associations. Expertise and counter-expertise thus become a way to define a cause and sometimes to challenge governmental actions.

Conclusion

A somewhat contradictory view of the state of research in Jordan has emerged. Jordan has set up high level institutions, that promote, orientate and sometimes fund research in Jordan, without however directly managing it, apart from some specific projects. Jordan is still very marginal when compared to the international level in general. However, bibliometric analysis shows a general growth pattern, especially in some disciplines of high specialisation: computer and information sciences, pharmacy/chemistry, and energy engineering. Researchers, however, do not show the same confidence as to whether research plays a central role. They often feel unable to do any research for lack of time and budgets, and view it as a marginal activity in their country. Access to data is also a specific problem for them. The way they deal with different levels of constraints confirms the importance of the local and international level in a globalised world, but also shows that the national institutions still play, or even reinforce, their role.

Research in Jordan appears to be integrated into an actual wider trend concerning peripheral and non-hegemonic countries¹⁸. The marked influence of international organisations, which bring budget and agenda, has direct consequences. This international influence does not necessarily orient research in Jordan towards a better cooperation with foreign research centers or a better integration on the international scene. 'The abundance of cooperation is both an asset and a risk: that of becoming a sub-contractor for trite verifications of front line science, or a pieceworker in leading edge programs without grasping all of their stakes' (Waast, 2008: 33). It tends to transform researchers into 'informants', well paid, but without impact on subjects, theoretical tools and analytical grids. So their participation in the world wide evolution towards expertise can not be considered as in opposition to 'the region's self-imposed technological dependency and reliance on western expertise' (Zahlan, 2006: 103 and UNDP, 2003). However, international organisations often profess that far from creating research thematics or research objects, they do directly answer to the concerns of the population. Moreover it is not sure that their colleagues, researchers in Western countries, have much more influence on the agenda of these organisations. This indeed raises a question about the relation between expertise and research, which is not a simple straightforward one. The design of the 'international agenda' is a process that does not only concern non-hegemonic countries; but its consequences on research may be more apparent in these countries than those with strong research institutions. As Ali al Kenz underlines, the 'epistemological action' of the international organisations and their paradigm remain less influential when 'scientific communities are strong and based on solid universities with the support of the State' (Al-Kenz, 2005: 9).

¹⁸ Non hegemonic or 'peripheral' countries are at a subordinated position in international power relations and do not have the means to influence the international agendas. They may however have some autonomy to format their national agenda and choose their cooperation partners. See Losego and Arvanitis (2009) and Larzillière (2008).

Table 1. Science and Technology Indicators in Jordan

| S &T Indicator | 1986 | 1996 | 2003 |
|--|-------|-------|-------|
| No. of institutions working in S&T activities | 196 | 524 | 835 |
| No. of employees working in S&T activities | 4389 | 18364 | 42151 |
| Out of which scientists and engineers | | | 15799 |
| No. of employees (scientists and engineers) working in R&D activity based on (FTE) ¹⁹ | 418 | 1593 | 1464 |
| Expenditure on S&T activities (million USD) | 101.4 | 150.1 | 695.4 |
| Expenditure on R&D activities (million USD) | 7.8 | 24.5 | 31.1 |
| Expenditure on education and training (million USD) | 55.6 | 93.8 | 148.3 |
| Expenditure on S&T services (million USD) | 37.9 | 31.8 | 514.2 |
| Expenditure on S&T activities To GNP (%) | 3.77 | 2.36 | 7.3 |
| Expenditure on R&D (%) | 0.29 | 0.38 | 0.34 |
| Expenditure on education and training (%) | 2.07 | 1.48 | 1.60 |
| Expenditure on S&T services (%) | 1.41 | 0.50 | 5.40 |
| Scientists & engineers working in R&D based on (FTE) for every 1000 inhabitants | 1.6 | 3.6 | 2.7 |

Source: Higher Council for Science and Technology-Jordan

¹⁹ The FTE was calculated based on responses of engineers and scientists on the following question: how much of your time (%) is devoted to teaching, R&D, management etc.; that is why there is such a difference between the number of engineers and scientists (15 799) and the Full Time Equivalent (FTE 1464).

Table 2. Arab Countries: Research Indicators (selection)

| | GERD as % of the GDP | NB of researchers per million of pop |
|----------------------|------------------------------|--------------------------------------|
| Maghreb | | |
| Algeria | 0.5 planned (0.25 allocated) | 906 |
| Morocco | 0.8 | 782 |
| Tunisia | 1 | 1400 |
| | | |
| Egypt | 0.2 | 1700 |
| | | |
| Near East | | |
| Jordan | 0.34 | |
| Lebanon | 0.22 | 4500 (?) |
| Syria | 0.12 | 29 |
| | | |
| Gulf | | |
| Bahrain | 0.04 | |
| Kuwait | 0.2 | 833 |
| United Arab Emirates | 0.1 | 875 |
| Qatar | | |
| Oman | 0.05 | |

Source: Waast, 2008: 9

Table 3. Scientific centers by chronological order of creation.

| Scientific centers | Year of creation |
|---|-------------------------|
| Affiliated to the HCST | |
| National Center for Human Resources Development | 1989 |
| The National Center for Diabetes Endocrine and Inherited Diseases (NCDID) | 1996 |
| National Energy Research Center | 1998 |
| Regional Human Security Center (RHSC) | 2000 |
| National Biotechnology Center | 2003 |
| Jordan Center for Public Policy Research & Dialogue | 2004 |
| Jordan Badia Research and Development Center | 2004 (as center) |
| National Network for Advanced Materials and Nano-Technology (NNAMNT) | 2004 |
| The Environment Monitoring & Research Central Unit (ENMARCU) | 2004 |
| Other Research Centers | |
| Royal Scientific Society | 1970 |
| National Center for Agricultural Research and Technology Transfer | 1991 |
| Pharmaceutical Research Unit | 1993 |

Table 4. Research and Development Budget Indicators of Scientific Centers (2006)
(Thousand J.D)

| Scientific Centers | Number of employees | Direct R&D Budget Indicators | | | | Other R&D Budget Indicators | |
|---|---------------------|------------------------------|-------------|--------------|--------------|-----------------------------|----------------|
| | | R&D Projects | Lab. equip. | Total | % | Salaries | Other Projects |
| Royal Scientific Society | 668 | 2391 | - | 2391 | 59.9 | 4437 | 1106 |
| National Center for Human Resources Development | 39 | 109 | 6 | 115 | 2.9 | 370 | - |
| National Center for Agricultural Research and Technology Transfer | 416 | 112 | 68 | 180 | 4.5 | 2071 | - |
| Jordan Badia Research and Development Center | 60 | 50 | - | 50 | 1.3 | 220 | - |
| National Biotechnology Center | 4 | 60 | - | 60 | 1.5 | 33 | 25 |
| National Energy Research Center | 31 | 34 | 43 | 77 | 1.9 | 324 | - |
| Jordan Center for Public Policy Research & Dialogue | 6 | 40 | - | 40 | 1.0 | 45 | - |
| Pharmaceutical Research Unit | 53 | 76 | 1000 | 1076 | 27.0 | 204 | - |
| Total | | 2872 | 1117 | 3989 | | | |
| % | | 72.0 | 28.0 | 100.0 | 100.0 | 7704 | 1131 |

Source: Questionnaire conducted by HCST, 2006. ‘

Table 5. Jordan's twenty-two universities, year of creation, academic staff, enrolled students and R&D budget

| University | Year of Creation | Academic Staff (2003/2004) | Enrolled Students (2003/2004) | Direct R&D Budget Indicators (2006) (Thousand J.D) |
|--|----------------------|----------------------------|-------------------------------|--|
| Public universities | | | | |
| Jordan University | 1962 | 1008 | 32317 | 9133 |
| Yarmouk University | 1976 | 721 | 19896 | 2033 |
| Mutah University | 1981 | 580 | 17237 | 1626 |
| Science & technology University | 1986 | 626 | 15330 | 5945 |
| Al-al Bayt University | 1992 | 187 | 13670 | 3000 |
| The Hashemite University | 1995 | 357 | 14393 | 5206 |
| Al Balqa Applied University | 1997 | 258 | 13195 | 2601 |
| Tafila Technical University | 1997 | | | 3285 |
| Al-Hussein Bin Talal University | 1999 | 78 | 3561 | 1921 |
| The German-Jordanian university | 2005 | | | |
| Private universities | | | | |
| Applied Science University | 1989 | 273 | 1757 | 526 |
| Al-Isra University | 1989 | 195 | 5314 | 407 |
| Philadelphia university | 1989 | 319 | 7307 | |
| Al ahliyya Amman university | 1990 | | | |
| Irbid National University | 1991 | 99 | 3918 | 368 |
| Zarka Private University | | 150 | 4222 | 231 |
| University of Petra | 1991 | 191 | 3172 | 436 |
| Princess Sumaya University | 1991 | 50 | 889 | 292 |
| Jerash Private University | 1993 | 160 | 4242 | 743 |
| Al-Zaytoonah University | 1993 | 217 | 7012 | 646 |
| Amman Arab University for Graduated Studies | 1999 | 189 | 5131 | 1050 |
| Jordan Applied University College of Hospitality & Tourism | 2003 (as university) | | | |
| total | | | | |

Source: Higher Council for Science and Technology

Table 6. Distribution of Academic Staff & Enrolled Students in Universities by Field of Study. Year 2003/2004

| Field of Study | | Academic Staff | Students | Students / Academic Staff |
|--|-----------|-----------------------------|-------------------------------|---------------------------|
| Education Science | Nbr. % | 321 5.6 | 26891 15.1 | 84:1 |
| Humanities, Religion | Nbr. % | 1008 17.7 | 28928 16.3 | 29:1 |
| Law | Nbr. % | 165 2.9 | 6432 3.6 | 39:1 |
| Social & Behavioral Science | Nbr. % | 285 5.0 | 6971 3.9 | 24:1 |
| Commercial and Business Administration | Nbr. % | 626 11.0 | 30183 17.0 | 48:1 |
| Natural Sciences | Nbr. % | 566 9.9 | 8826 5.0 | 16:1 |
| Mathematics & Computer | Nbr. % | 715 12.6 | 22228 12.5 | 31:1 |
| Medicine | Nbr. % | 274 4.8 | 3256 1.8 | 12:1 |
| Pharmacy | Nbr. % | 183 3.2 | 5050 2.8 | 28:1 |
| Para- Medical Science | Nbr. % | 257 4.5 | 7352 4.0 | 29:1 |
| Engineering | Nbr. % | 690 12.1 | 19828 11.2 | 28:1 |
| Agriculture | Nbr. % | 192 3.4 | 3367 1.9 | 18:1 |
| Others* | Nbr. % | 414 7.3 | 8745 4.9 | 21:1 |
| Total | Nbr. % | 5696 100.0 | 177511 100.0 | 31:1 |
| *Others include Fine and Applied Arts, Mass Communication &Doc., Physical Education, Dentistry ,Architecture &Town Planning, Applied Engineering ,and Veterinary M. | | | | |

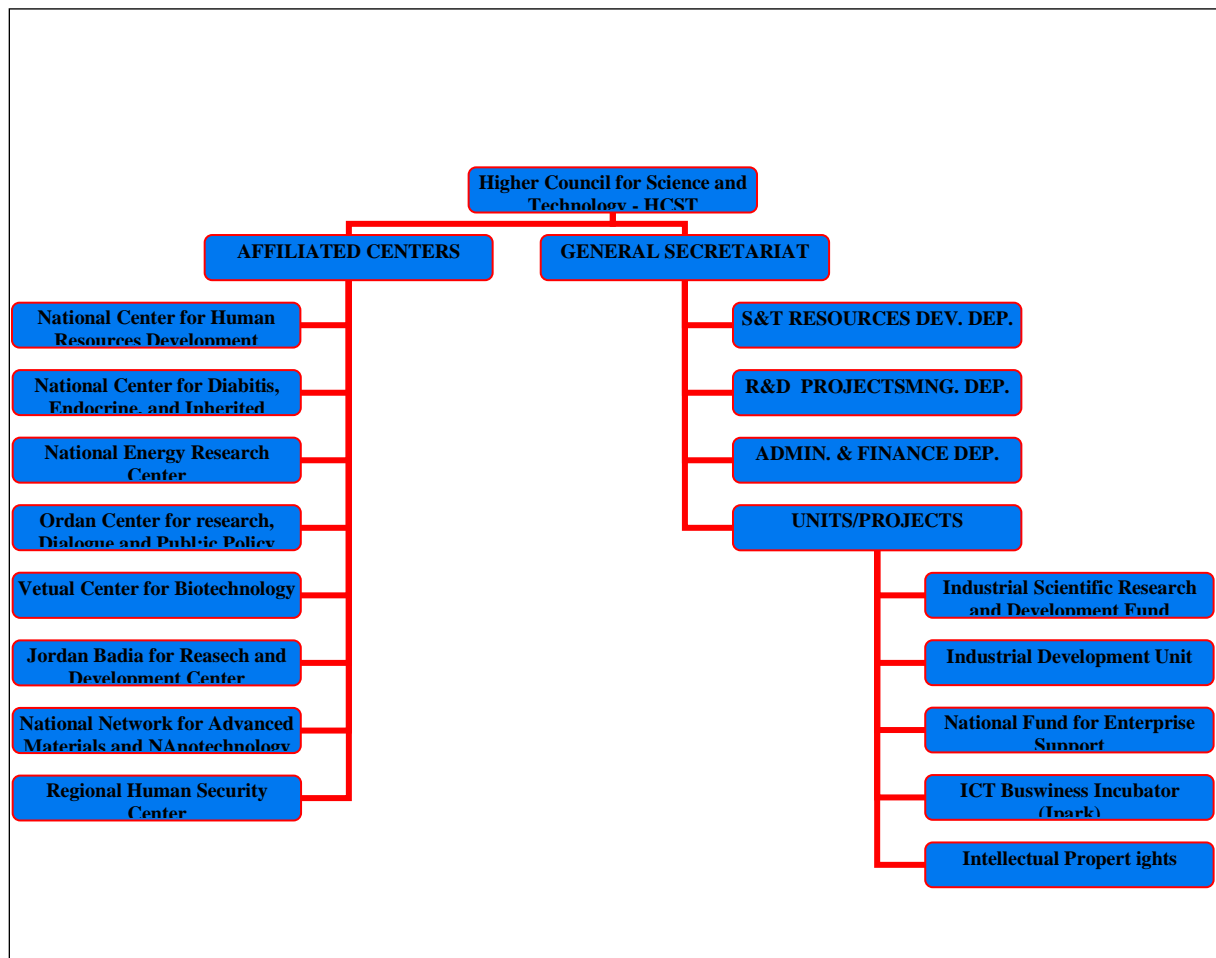
Source: Annual Statistical Report on Higher Education in Jordan (2003/2004), Ministry of Higher Education & Scientific Research, 2005.

Table 7. First partners by subject areas (% of co-publications by country on all publications) 1999-2009.

| | Electrical engineering | Chemistry and engineering, chemical | Medicine | Environmental Sciences | Mathematics | Computer Sciences |
|-----------|-------------------------------|--|-----------------|-------------------------------|--------------------|--------------------------|
| 1. | USA 20 | Germany10.5 | USA 6 | USA 10.5 | USA 8.5 | USA 15 |
| 2. | Canada 5 | USA 7.5 | England 2.5 | Germany 5 | UAE 7.5 | England 5 |

Source: SCI expanded. Web of Science. Thomson Reuters.

Figure 1. The organisational structure of the HCST



Source: HCST

Figure 2. Enrolment in total tertiary

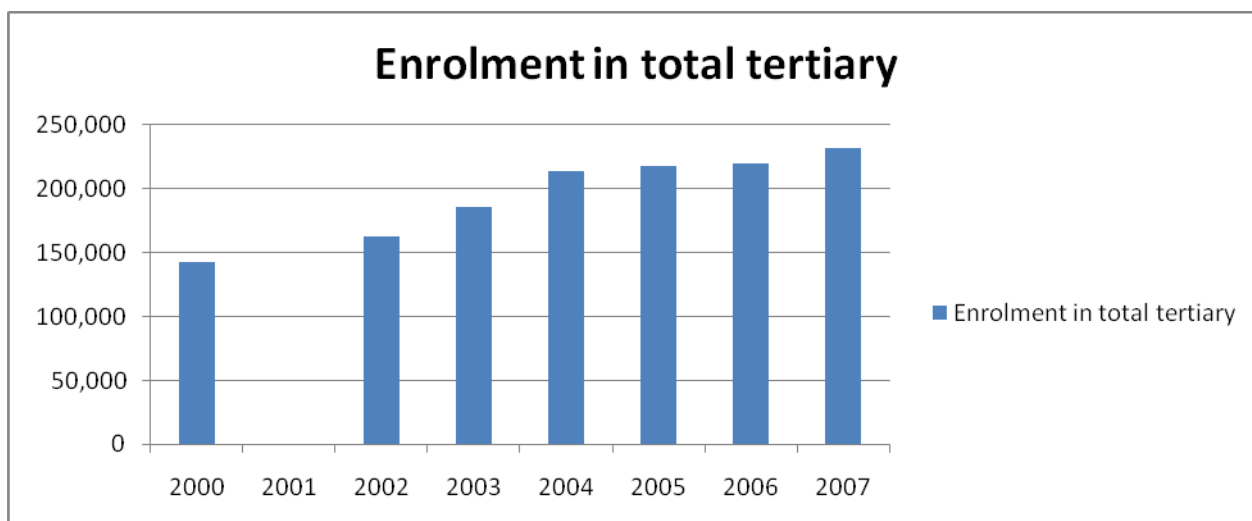
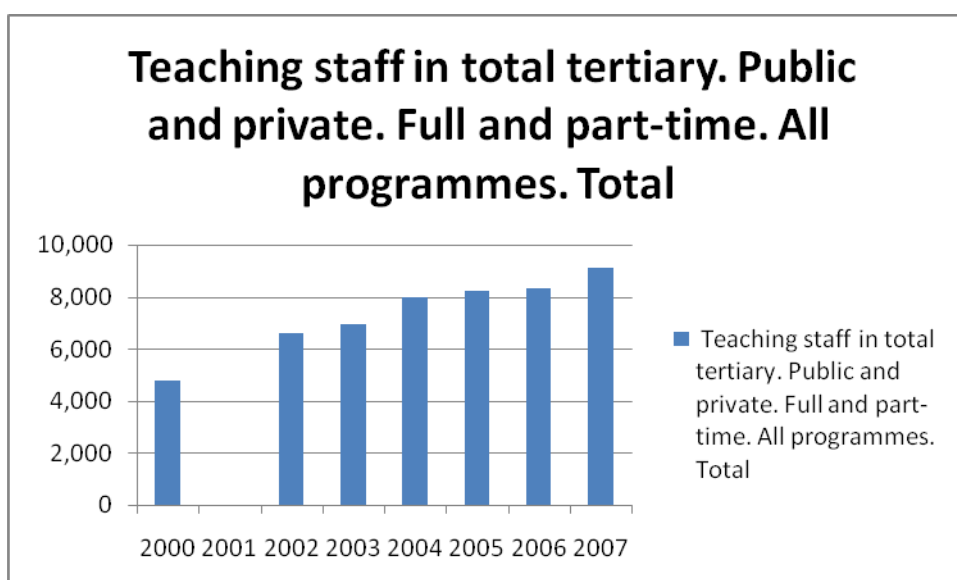
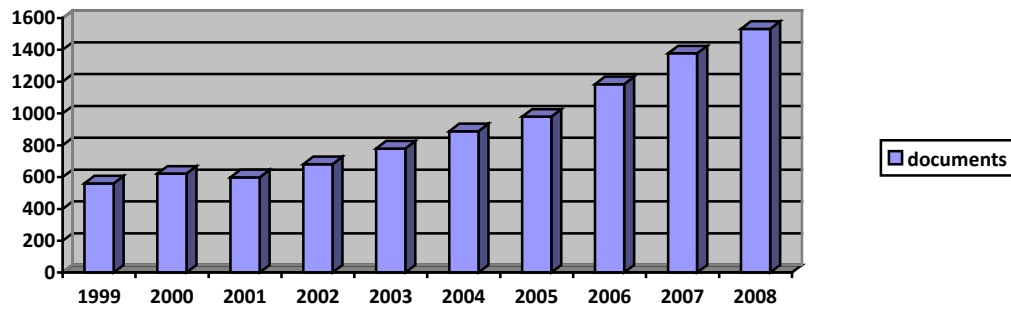


Figure 3. Teaching staff in total tertiary



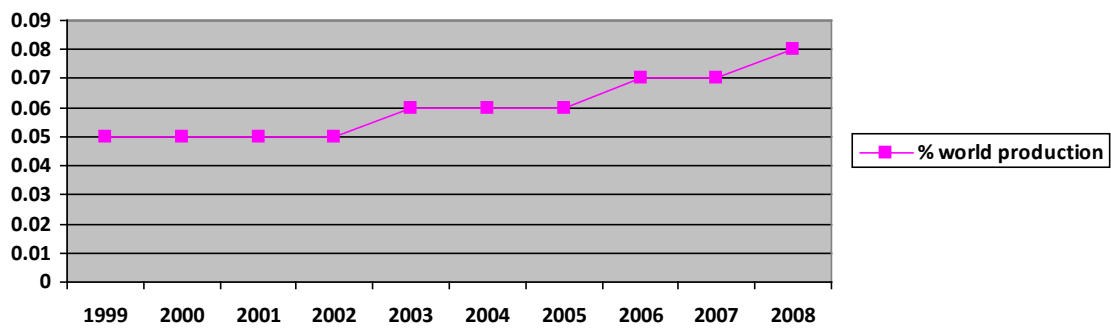
Source: UNESCO Institute for Statistics.

Figure 4. Jordan. Scientific production 1999-2008.



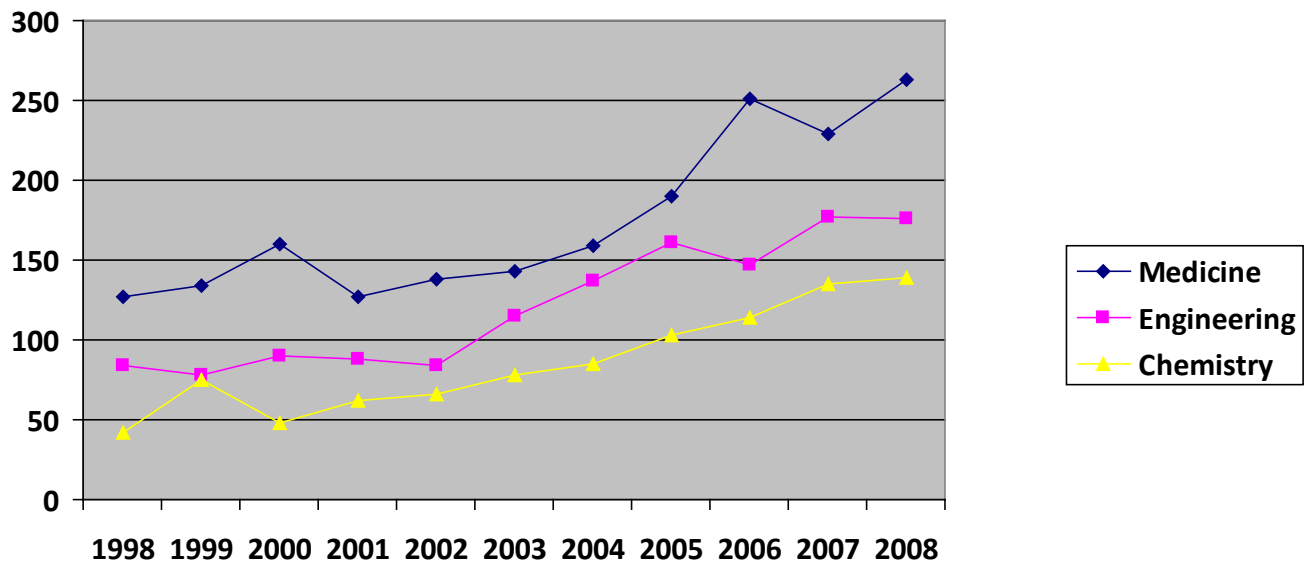
Source: SCImago. (2007). SJR — SCImago Journal & Country Rank. Retrieved April 15, 2010, from <http://www.scimagojr.com>.

Figure 5. Jordan. Relative scientific production 1999-2008



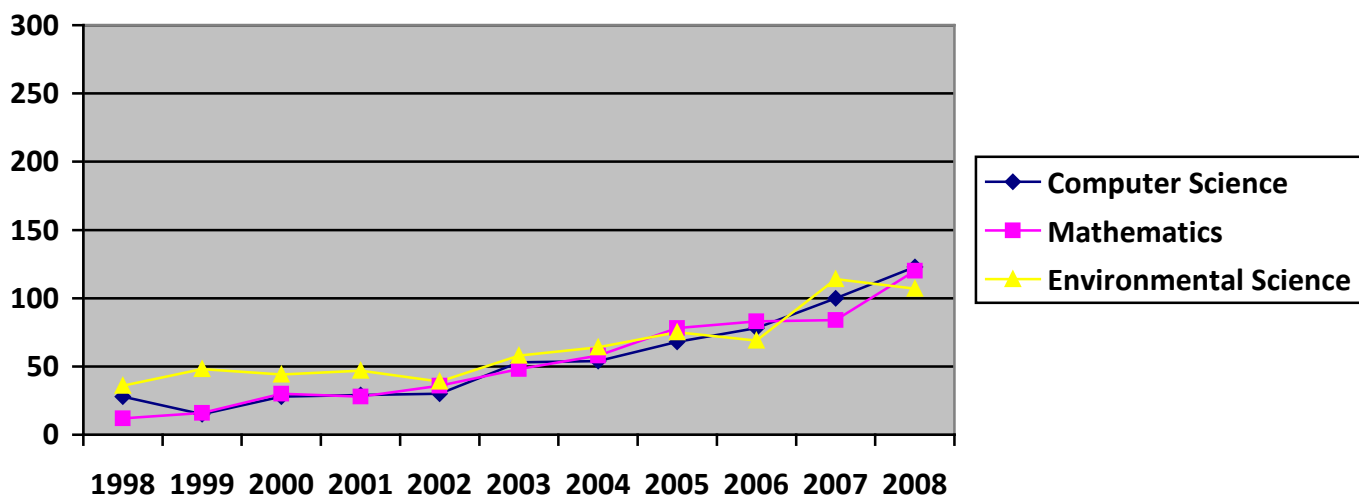
Source: SCImago. (2007). SJR — SCImago Journal & Country Rank. Retrieved April 15, 2010, from <http://www.scimagojr.com>.

Figure 6. Jordan. Top 3 subject areas evolution.



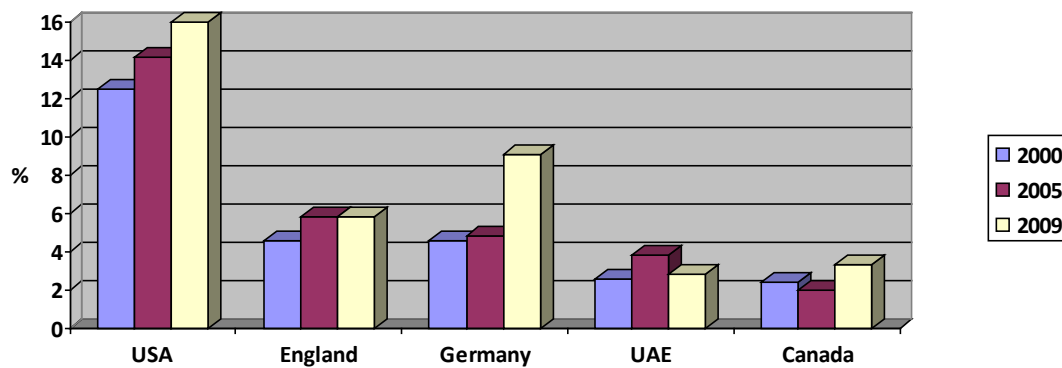
Source: SCImago. (2007). SJR — SCImago Journal & Country Rank. Retrieved April 15, 2010, from <http://www.scimagojr.com>.

Figure 7. Evolution of three other main subject areas.



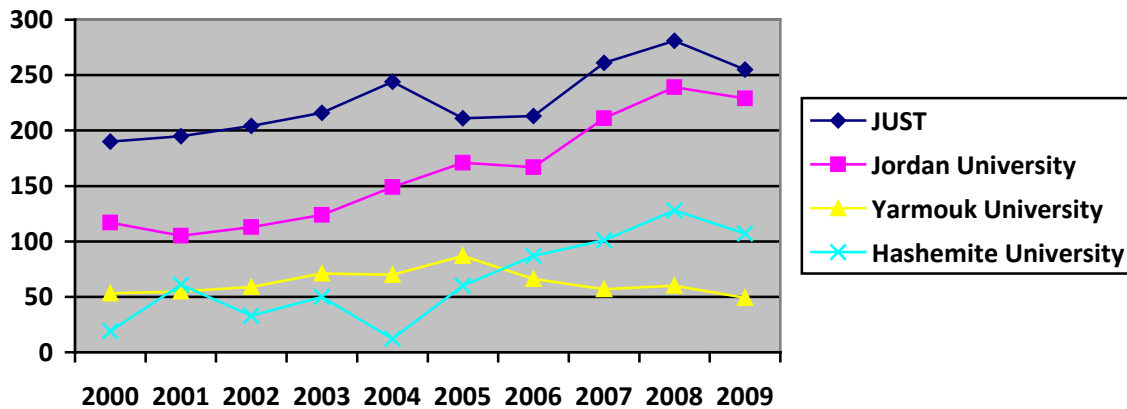
Source: SCImago. (2007). SJR — SCImago Journal & Country Rank. Retrieved April 15, 2010, from <http://www.scimagojr.com>.

Figure 8. Jordan. Top 5 Scientific partners (% of co-authored publications [axe y] with foreign partners [axe x])



Source: SCI expanded. Web of Science. Thomson Reuters.

Figure 9. Scientific production of main universities. 2000-2008



Source: SCI expanded. Web of Science. Thomson Reuters

REFERENCES

- Al-Husban, A. (2007), *Research in Social Sciences in Jordan*, intermediate report for ESTIME, 56 pages.
- Al-Kenz, A. (2005), *Les sciences sociales dans les pays arabes*, 11 pages. <http://www.estimate.ird.fr/article50.html>
- Alouran, N. (2006), *Research in the Exact Sciences in Jordan*, intermediate report for ESTIME, 22 pages.
- Arvanitis, R. ed (2007), *Towards Science and Technology Evaluation in the Mediterranean Countries*, Final Report for the ESTIME project, http://www.estimate.ird.fr/IMG/pdf/FINAL_report_ESTIME-2.pdf
- Augé, J-C. (1997), 'Système d'enseignement supérieur et populations étudiantes en Jordanie : pistes de recherche', *Jordanies* (n°3), pp 127-133.
- Cantini, D. (2008), *Understanding Higher Education: an Ethnographic Perspective from Jordan*, paper for the International Conference on Ethnography and Education, Oxford, UK, St. Hilda's College, 16-17 September 2008, 10 pages.
- Crane, D. (1972), *Invisible Colleges*, Chicago, University of Chicago Press, 213 pages.
- De Bel-Air, F. (2003), 'Migrations internationales et politique en Jordanie', *Revue européenne des migrations internationales*, 19 (3), [On line]. URL : <http://remi.revues.org/index2651.html>.

- Elshuraydeh, K. and I. Mustafa, eds (2006), *Science & Technology and Innovation Profile of Jordan*, Report for Estime Project, Higher Council for Science and Technology, 100 pages.
<http://www.estimate.ird.fr/article197.html>
- Gaillard, J. (1991), *Scientists in the Third World*, Lexington: University Press of Kentucky, 244 pages.
- Gaillard Jacques, V.V. Krishna and R. Waast, eds (1997), *Scientific Communities in the Developing World*, New Delhi: SAGE India, 398 pages.
- Gaillard Jacques and A.M. Gaillard (1997) 'The International Mobility of Brains: Exodus or Circulation ?', *Science, Technology & Society*, Vol. 2(2), pp 195-228.
- INSTITUT FRANÇAIS DU PROCHE-ORIENT (2007), Répertoire des chercheurs et des centres de recherche Jordanie, Liban, Syrie, 45 pages.
http://www.estimate.ird.fr/IMG/pdf/rapport_IFPO_2007.pdf
- Jordanian Ministry of Planning and International Cooperation, *Executive Program 2007-2009*, Amman, 169 pages. On line: www.mop.gov.jo
- Larzillière, P., ed (2007), *Research in Jordan*, Estime Country Report, 54 pages.
- Larzillière, P. (2008), 'Sociology from a "Peripheral" Angle', paper for the symposium organised by Geoffrey Pleyers *Methodology and Research Experience in the Global Age*, LSE-London and ICP-Paris, 7-9 February 2008.
- Larzillière; P., 'Les organisations professionnelles comme arène alternative de mobilisation politique en contexte coercitif : le cas de la Jordanie', *Critique internationale*, to be published.
- Longuenesse, E., ed (1990), *Bâtisseurs et bureaucrates : ingénieurs et société au Maghreb et au Moyen-Orient*, Collection Etudes sur le monde arabe n°4, Lyon, Maison de l'Orient, 435pages.
- Longuenesse, E. (1990), 'Ingénieurs et marché de l'emploi en Jordanie' in *Bâtisseurs et bureaucrates : ingénieurs et société au Maghreb et au Moyen-Orient*, Lyon, Maison de l'Orient, pp. 127-145.
- Longuenesse, E. (2000), *Les syndicats professionnels en Jordanie : enjeux de société et lutte nationale*, unpublished, available on <http://halshs.archives-ouvertes.fr/halshs-00111075/>
- Longuenesse, E. (2007), *Professions et société au Proche-Orient : déclin des élites, crise des classes moyennes*, Rennes, Presses Universitaires de Rennes, 254 pages
- Losego, P. and R. Arvanitis (2008), 'Les savoirs dans les pays non-hégémoniques', *Revue d'Anthropologie des Connaissances*, 2 (3), pp 334-342.

- Nour Samia Satti O.M. (2005), 'Science and Technology Development Indicators in the Arab Region: A Comparative Study of Arab Gulf and Mediterranean Countries', *Science, Technology and Society*, 10 (2), pp 249-274.
- Romani, V. (2008), *Sciences sociales et coercition : Les 'social scientists' des Territoires palestiniens entre lutte nationale et indépendance scientifique*, Ph.D. Dissertation, Université Aix-Marseille III/ Institut d'Etudes Politiques d'Aix en Provence, 452 pages.
- Rossi, P. L. and R. Waast (2007), *Scientific production in sub-disciplines - 1995-2003 (Algeria, Morocco, Tunisia, Egypt, Lebanon, Jordan, Syria)*.
<http://www.estimate.ird.fr/article238.html>
- Samha, M. (1990), 'The impact of Migratory Flows on Population Changes in Jordan: a Middle Eastern Case Study', *International Migration*, vol XXVIII n°2, pp 221-227.
- Signoles, A. (2006), 'Réforme de l'Etat et transformation de l'action publique : analyse par les politiques publiques' in E. Picard, ed (2006), *La politique dans le monde arabe*, Paris, Armand Colin, pp 239-261.
- United Nations Development Program and Arab Fund for Economic and Social Development (2003), *Arab Human Development Report 2003: Building a Knowledge Society*, New York, XVI +210 pages.
- WAAST, R. (2008), *Study on National Research Systems, Draft Regional Report on Arab Countries*, UNESCO. 43 pages. On line: www.unesco.org
- Wagner, C. S. (2008), *The New Invisible College Science for Development*, Washington D.C.: Brookings Institution Press, 200 pages.
- Wagner, C. S. and L. Leydesdorff (2005), 'Network Structure, Self-Organisation and the Growth of International Collaboration in Science', *Research Policy*, 34 (10), pp. 1608-1618.
- Wils, O. (1998), 'L'aide étrangère depuis 1989 et son impact sur l'économie politique jordanienne : quelques questions de recherche', *Jordanies*, Recherche et Documentation : Politique, Economie et Société, 6 (12), n° 5-6, pp 100-119.
- Zahlan, A. B. (1990), 'Formation et emploi des ingénieurs arabes', in Longuenesse, E. ed (1990), *Bâtisseurs et bureaucrates : ingénieurs et société au Maghreb et au Moyen-Orient*, Collection Etudes sur le monde arabe n°4, Lyon, Maison de l'Orient, pp 111-126.
- Zahlan, A. B. (2006). 'Arab Society as Knowledge Society: Essay Review', *Minerva*, n° 44, pp 103-112.
- Zuccala, A. (2006). 'Modeling the Invisible College', *Journal of the American Society for Information Science and Technology*, 57 (2), pp. 152-168