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UNESCO FORUM
on Higher Education, Research and Knowledge

Study on National Research Systems
A Meta-Review

REGIONAL REPORT ON ARAB COUNTRIES

Compiled by R. Waast

2007

UNESCO

THE UNESCO FORUM ON HIGHER EDUCATION, RESEARCH AND KNOWLEDGE

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Study on National Research Systems

A Meta-Review

Compiled by Roland Waast

Contributions by Jacques Gaillard, Sari Hanafi, A. H al Huzban, Hocine Khelfaoui, Mina Kleiche, Pénélope Larzillière.

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Arab Countries

Table of contents

SECTION 1: INTRODUCTION AND SOURCES.

This Report draws information from monographs, books and journal articles less than six years old and dealing with the status (or aspects of it) of S&T in 11 Arab countries. We have compiled in our "Meta review" the best of them (most complete and recent, in English) restricted to one item for each country.

The countries dealt with are: **Algeria, Morocco and Tunisia** (called together the "Maghreb" sub region); **Lebanon, Jordan and Syria** (called together "Machreq"); **Bahrain, Kuwait, Oman, Qatar and United Arab Emirates** (called together "Gulf" countries).

Egypt is dealt with in this Report, though we could not find any comprehensive monograph recently completed on that country. We had to draw from a monograph of 2001 and from scattered data (national and international sources).

We could not find reliable data on Iran; we replaced it by information on Qatar which was not in our brief but should clearly have been included. The compilation of case studies also includes Sudan (which is dealt with in the African report) and some data on Saudi Arabia.

Information is clearly uneven. In some cases we came across good and detailed monographs (as for Maghreb countries, mostly in French). In other cases we had great difficulties to find coherent and comprehensive data (if any). The Gulf countries are an example, and also Egypt and Syria (we found reports on specific aspects). We'll come back to this point in our conclusion, for one lesson is that there is an urgent need of data and standardized studies in the region, indeed of "Observatories of S&T" as those some countries contemplate establishing (Tunisia, Lebanon, Morocco).

Fortunately, we could lean on some excellent and recent surveys of the zone (or sub zones) and we must point them out and acknowledge them:
* One source is the complete range of substantial monographs dedicated to "Science in Africa" (a European project about 15 countries, including Morocco, Algeria and Egypt)[1]. All these monographs can now be unloaded free of charge from www.ird.fr/fr/science/dss
* Another generous source (up to date) derives also from a European project. This ESTIME project was managed by R. Arvanitis and targeted 8 Mediterranean countries. It involved numerous teams of the region, and the contribution of science officials in each country. A number of reports have been issued and they can be unloaded from www.estime.ird.fr/ ; Synthetic country reports have been released very recently, and we were kindly authorized to consult and quote them. The present Report draws a lot from them especially about Morocco (Kleiche), Algeria (Ziour & Benguerna), Tunisia (M'Henni), and most notably Lebanon (Gaillard) and Jordan Larzillère). All these monographs are in English.
* In spite of many difficulties, S. Hanafi gathered a range of facts about science in the Gulf countries (even when there are not policies in the strict literal sense of the word).

We added to our investigation a number of *bibliometric analyses*. This went beyond our brief. But they offer an interesting view on the output of research in the region, and its positive development.

The paradox in this part of the world is that one comes across obvious talents, pulling greatly the output upwards; while no specific goal is commonly ascribed to research. The social inscription of science remains unsteady and the proper *function* of research is vague.

Moreover there are great differences between sub-regions (the Gulf countries, Machreq, Maghreb) and even between countries[2] as for the age and context of scientific activity, the socio cognitive blocs supporting it, the nature of institutional arrangements, financing and organizing solutions.

We'll first look at a few indicators and significant descriptors. We'll then go through a longer discussion of the particulars of the region and the main features of the context, recent trends in governance and policies, institutional setting and human resources.

SECTION 2: INDICATORS

[1] M. Kleiche authored *Morocco*, H. Khelfaoui *Algeria* and S. Radi *Egypt*. Monographs are in French, but the best pages were published in English by the *Science, Technology & Society* journal (8:2 and 9/1, 2003 and 2004).
[2] Egypt being a peculiar case, as the oldest and largest producer of science in the region.

ARAB COUNTRIES. INDICATORS

If no other Key : Year 2003 (to allow comparisons through the world)
Sources: World Bank or UN organizations; World Economic Forum for Value chain presence

Arab countries: Economic indicators

	GDP $ billions 2003b (WDI 2005)	PPP gross national incomea/ Per capita $/ 2003(Wdl 2005)	PPP gross national incomea/ Per capita / Rank 2003(WDI 2005)	GDP per capita annual growth rate % 1975-2004 (UNHDR 2006)	Manufacturing, value added (% of GDP)(WB2003)	Value chain presence Rank/131	Personal computersa per 1,000 people 2003(WDI 2005)
Maghreb							
Algeria	61,6	5930	103	0,1	7,1	118	8
Morocco	39,4	3940	132	1,4	16,7	71	20
Tunisia	22,2	6850	92	2,3	17,87	29	41
Egypt	93,9	3940	132	2,6	19,57	44	22
Near East							
Jordan	9,8	4290	129	0,5	17,22	55	45
Lebanon	18,2	4840	124		13,47		81
Syrian Arab Republic	20,2	3430	138	1,1	..	73	19
Gulf							
Bahrain		25.300 / 15.900		1,2	..	77	…
Kuwait	43	19480d	43	-0,8	2,35	66	163
United Arab Emirates	..	49 700	34	-2,8	13,12	52	129
Qatar						62	
Oman					8,25	53	

Arab countries: Social indicators

	Total Population millions 2003 (WDI 2005)	Fertility rate, total (births per woman)(WB2003)	Health expenditure, total (% of GDP)(WB2003)	Total public expenditure on education as a % of GDP	HDI rank (UNHDR 2006)	Poverty headcount ratio at $2 a day (PPP) (% of population)(UNHDR2006)1990-2004	Net migration thousands 2000(WDI 2005)	Urban population (% of total)(WB2003)
Maghreb								
Algeria	32	2,5	4,1	...	102	15,1	-185	62
Morocco	30,1	2,5	5,1	6,3	123	14,3	-300	57
Tunisia	9,9	2,06	5,6	6,4	87	6,6	-20	65
Egypt	67,6	3,23	5,9	...	111	43,9	-500	43
Near East								
Jordan	5,3	3,45	9,4	...	86	7	35	82
Lebanon	4,5	2,3	10,2	2,6	78	..	-30	86
Syrian Arab Republic	17,4	3,39	5,1	...	107	..	-30	50
Gulf								
Bahrain		2,43	4,1	...	39	..		96
Kuwait	2,4	2,52	3,5	8,2	33	..	347	98
United Arab Emirates	4	2,36	3,3	1,6	49	..	567	77
Qatar	1	2,89						95
Oman	2,5	3,44		4,6				72

Arab countries: Higher Education indicators

	Total enrolment 2004			Gross enrolment Tertiary edu 2004	Public expenditure per student as a % of GDP per capita	Teaching staff		Total number of graduates	
	MF	%F	%Private		Tertiary	MF	%F	MF	% F
Maghreb									
Algeria	716 452	51	...	20	...	26 097	32	...	...
Morocco	343 599	46	5	11	87	18 593	23	27 001	42
Tunisia	263 414	55	-	29	63	12 937	38	26 435	49
Egypt	2 153 865	...	18	29	...	72 592	...	342 902	...
Near East									
Jordan	186 189	51	37	35	...	6 949	20	37 825	50
Lebanon	154 635	52	49	48	15	19 913	37	23 681	54
Syrian Arab Republic	190 000	...	...	14	...	7 500	...	...	...
Gulf									
Bahrain	18 524	63	...	34	...	832	36	2 555	70
Kuwait	42 076	71	...	22	173	1 643	23	...	...
United Arab Emirates	68 182	66	...	22	...	2 948	...	...	...
Qatar				19					
Oman	33 807	56	29	13	54	1 144	25	5 059	62

Note on the Research Indicators (next page):

Teaching staff numbers come from UNESCO Education global digest. We did not revise them, even when field studies show (Lebanon, etc) that a great number of teachers work in several establishments (public and private) or are on temporary and part time positions.
With the help of authorities, we established the Full Time Equivalent (FTE) numbers.

Other data (Researchers in Government and Industry, *FTE estimations*) come from monographs; especially from : "*Science in Africa*" project: Khelfaoui for Algeria; Kleiche for Morocco; "***ESTIME*** project": Ziour for Algeria, H. M'Henni for Tunisia; J. Gaillard for Lebanon; P. Larzilliere & I. Mustafa fro Jordan
Science Technology & Society journal : passim (and Nour concerning Indicators for Arab countries)

All these data (and estimations) have been discussed and revised with managers in charge at appropriate levels (government, Universities, Centres).

The number of Publications is the figure given by the ***SCI non extended*** (which allows comparisons through the world for long periods).

Arab countries: Research indicators

	GERD as % of GDP	Teaching staff (Univ)	Other researchers (Gov + Indus)	Ph D students	Total Researchers Headcount	Nb researchers per million of pop	Total Researchers FTE	Nb researchers FTE per million of pop	SCI publis 2005	SCI pubs per million of pop	SCI publis per GDP (per billion $)
Maghreb											
Algeria	0,5 prévus (0,25 alloués)	26 097	2 000	20 000	29 000	906	8 000	250	555	17	9
Morocco	0,8	18 593	4 500	17 000	23 000	782	6 600	220	850	28	22
Tunisia	1	12 937	1 000	9 700	14 000	1 400	6 200	630	929	94	42
Egypt	**0,2**	72 592	15 000 + indus		90 000	1 350	25 000	370	2331	35	25
Near East											
Jordan	0,34	6 949	1 000	1 000	9 000	1 700	2 200	410	421	79	43
Lebanon	0,22	19 913	300	500	20 000	4500 ?	1 000	200	431	95	24
Syrian Arab Republic	0,12	...				29			146	8	7
Gulf											
Bahrain	0,04	832			1 000				55	70	6
Kuwait	0,2	1 643			2 000	833		69	344	143	8
United Arab Emirates	0,1	2 948			3 500	875			410	103	6
Qatar									77	77	4
Oman	0,05	1 144			1 200				169	68	9

Arab countries. Opinions from business executives (World Economic Forum, Competitivity report)

	Brain drain Rank/131	Company spending on R&D Rank/131	Quality of scientific research institutions Rank/131	University-industry research collaboration Rank/131	Local availability of specialized research & training services Rank/131	Firm-level technology absorption Rank/131	Value chain presence Rank/131	FDI and technology transfer Rank/131	Capacity for innovation Rank/131	Quality of management schools Rank/131	Availability of scientists and engineers Rank/131
Maghreb					World Ec Forum						
Algeria	**105**	92	85	104	103	69	118	112	123	91	21
Morocco	79	75	83	66	59	42	71	44	93	26	20
Tunisia	43	36	33	32	33	36	29	34	31	20	10
Egypt	**113**	**99**	**96**	**95**	**80**	**60**	44	**51**	**84**	**89**	**40**
Near East											
Jordan	90	96	74	84	63	56	55	64	75	77	26
Lebanon					…					…	
Syrian Arab Republic	86	108	109	117	100	85	73	122	108	106	43
Gulf											
Bahrain	24	119	120	124	97	53	77	69	122	78	99
Kuwait	9	81	57	85	54	39	66	121	112	60	64
United Arab Emirates	6	42	60	48	42	21	52	15	72	52	83
Qatar	2	42	49	60	58	43	62	11	61	40	83
Oman	4	86	103	86	43	50	53	42	110	63	76
Moyenne	50_60	40_50	50_60	55_60	60	60_65	50	65	45	65	70

Key

Value chain: Just export or design and services added

Innovation: just by licensing & imitation or through R&D and developmt of own products and processes

1° quart	2° quart	3° quart	4° quart

SECTION 3: DESCRIPTORS

Arab countries. General description of the S&T systems

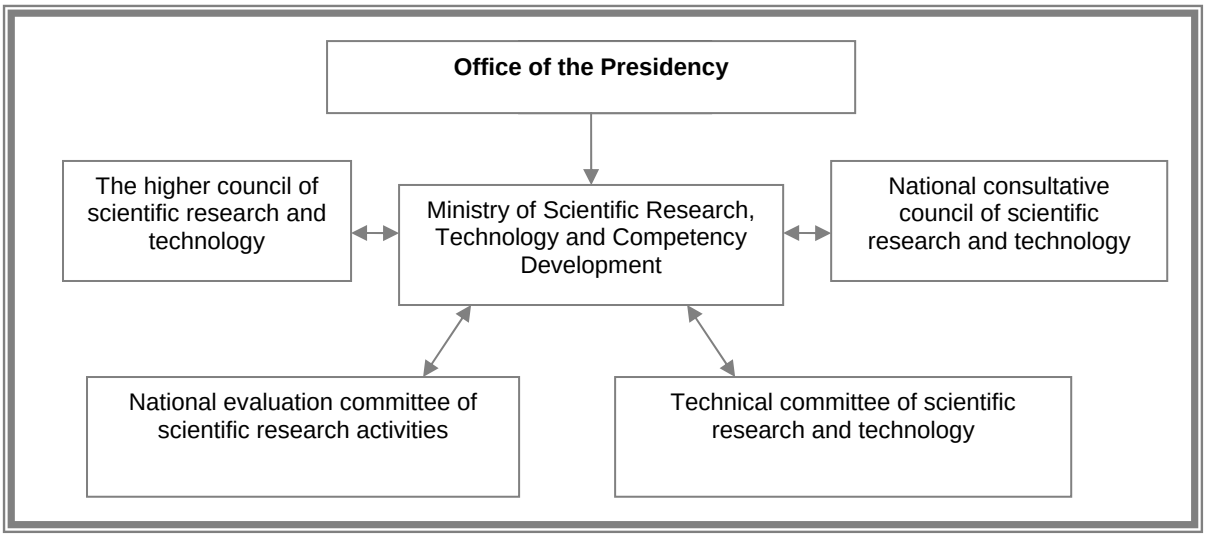
Country	S&T Policy document	Ministry of S&T	Funding Agencies	Other Funding Mechanisms	Type of governance	GERD / GDP %
Algeria	**Yes** (National Plan, 1998)	**Yes** Min of state reporting to Min of 3ry Edu	ANRU, ANRS, ANVRST Et al.	PNR (Nat Progr of Res) + National Fund RTD + etc	Centralized	0,25 *
Morocco	**Yes** (Vision 2006)	**No longer** (since 2004)	CNRST	Various Funds to support innovation: PTI, Incubators Etc	Centralized	0,8 *
Tunisia	**Yes** (5th Plan & following Plans since 1977)	**Yes** Full Ministry	Nat Sc Res Foundation (since 1989) Et al.	Various Funds to support innovation: FRP, NPRI, PTI, Techparks Etc	Centralized	1,0 *
Egypt	No	**Yes** + Ac of Sc	Several	Initiatives from various Ministries: Agri, Indus, Telecom, etc.	Centralized	0,2 **
Lebanon	**Yes** STIP = Vision (2006)	**NO**	CNRS Since 1962	Performers get contracts from all sorts of sponsors	Grassroots	0,22 *
Jordan	No	**NO**	HCST since 1987	Performers get contracts from all sorts of sponsors	Grassroots	0,34 *
Syria	No	**NO**	No		Grassroots	0,12 **
Bahrain	_	**NO**	BCSR (acting as agency)		Trade oriented	0,04 **
Oman	_	**NO**	OCIPED Invest Promo 2002	Sponsors	Trade oriented	0,07 **
Emirates	_	**NO**		Sponsors	Trade oriented	0,2
Qatar	_	**NO**	Qatar Foundation	Sponsors	Trade oriented	0,6 **
Kuwait	_	**Yes** Min High Edu & Sctf Res	KFAS Funding & coord since 1988	Sponsors	Trade oriented	0,2
Saudi Arabia			KACST since 1977			0,14 **

GERD / GDP as %. *Source* : Recent Monographs, especially from ESTIME project * or from Nour's article ** in *Science, Technology & Society* journal.

Governance (case studies):

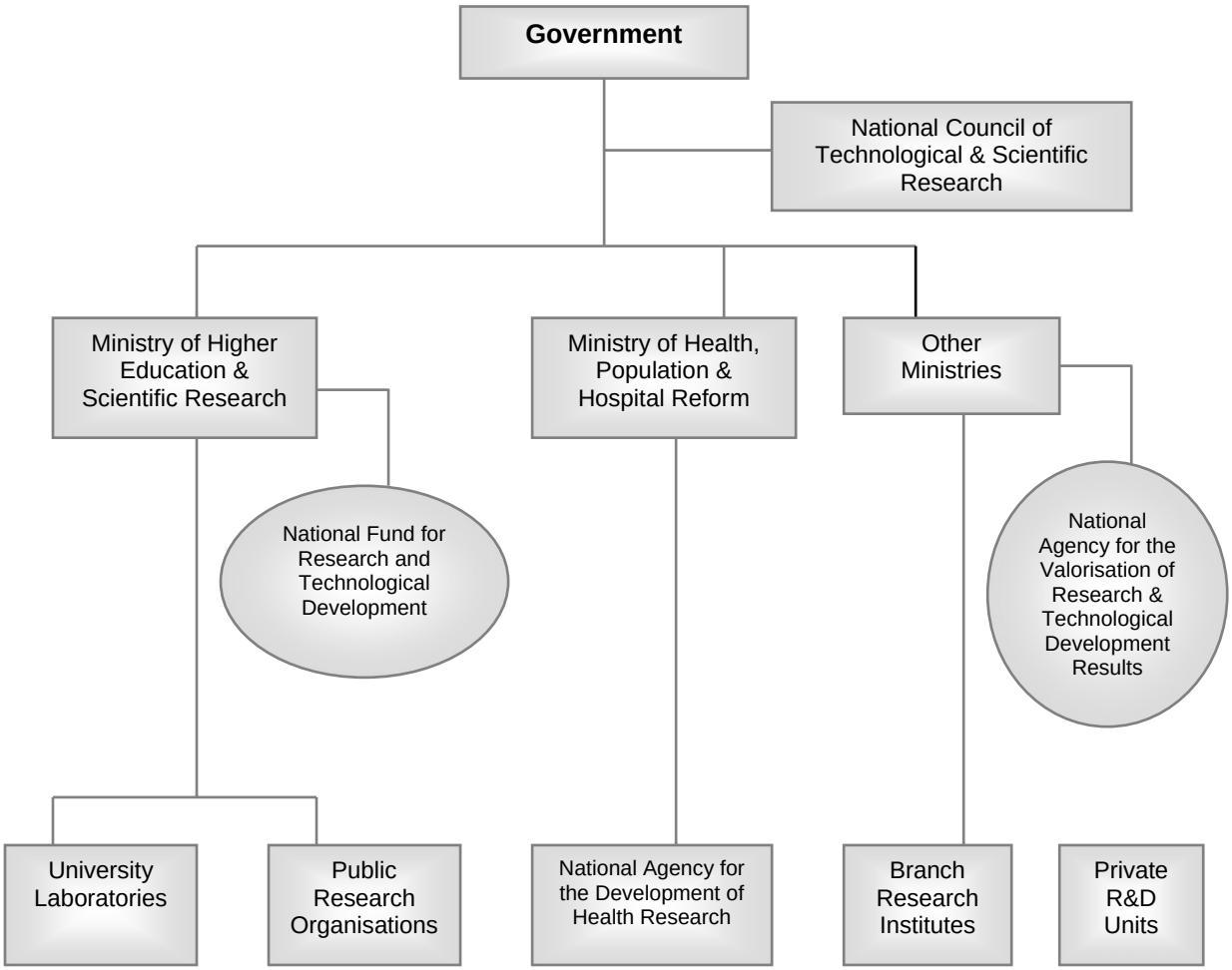
Centralized governance: Organization chart for Algeria and Tunisia

Simplified Illustration of the institutional arrangements in S&T in <u>TUNISIA</u>



N.B. For Tunisia: Performers are **<u>under</u>** this stratum

Organizational chart of the <u>ALGERIAN</u> S&T governance System



Governance (case studies):

*Non centralized governance: Mandate of the CNRS in **Lebanon***

(Extract from J. Gaillard, ESTIME Report on Lebanon, revised by M. Hamzé, Secretary General CNRS)

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 NCSR 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).

The CNRS is governed by a Board of Administration and managed by a General Secretariat. 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. The main part of the CNRS budget comes from the Lebanese government. 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. 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[3],
- The Research Grant Programme (RGP)[4],
- The PhD Fellowship Programme,
- The Science and Technology Culture Programme[5],
- The CNRS Associated Research Units (URA).

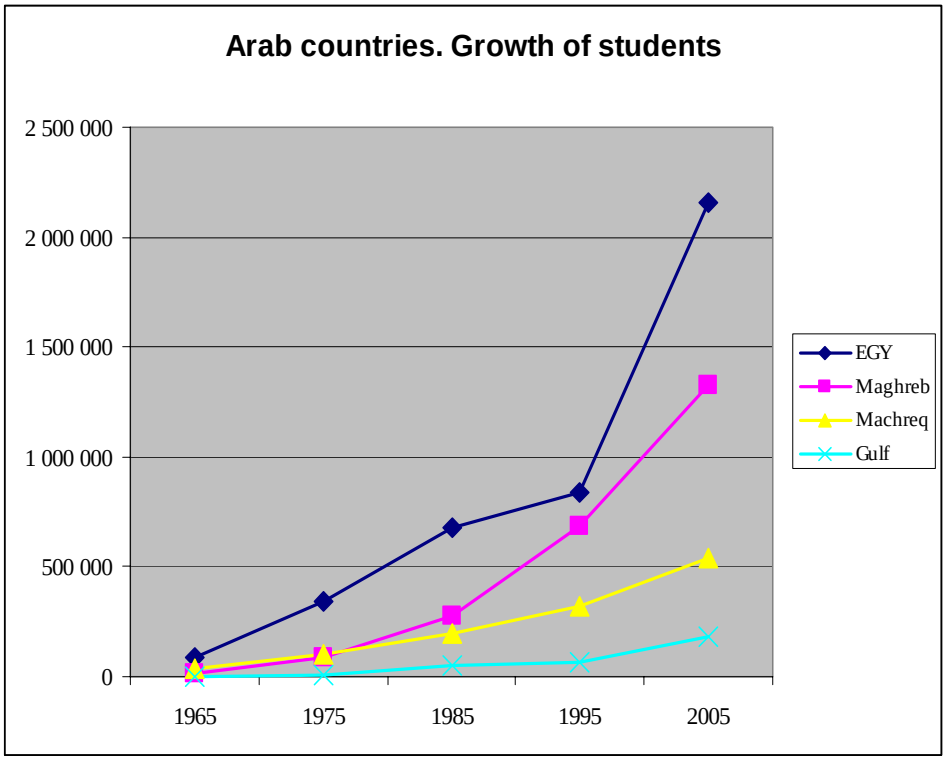
[3] Elaborating a Vision document

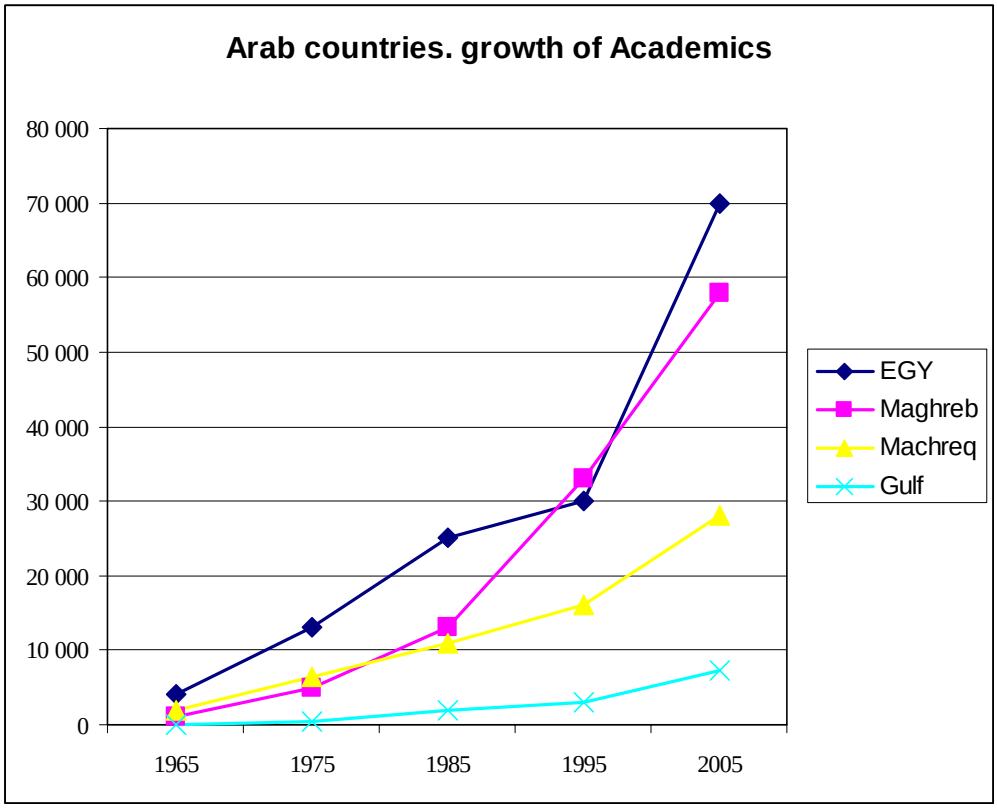
[4] A CNRS tool for sponsoring research projects implemented in public and private universities, and in national or private research institutions. Since 2000, one or two calls for applications have been launched every year. Over the last seven years (2000-2006), 614 projects have been approved for a 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.

[5] Popularizing Science

UNIVERSITIES:

Growth of the number of students





HUMAN RESOURCES: PROFESSION

Remuneration of Academics in Jordan

(Extract from P. Larzilliere, ESTIME Report on Jordan, here based on a contribution from Abdel Hakim al Huzban, Yarmouk University).

According to the regulations of higher education in Jordan, a faculty member in a university is defined first as an instructor whose main job is to teach and whose work hours are teaching hours. In spite of that, job promotions in universities are entirely dependent upon research activity and record[6].

Number of credit hours that each staff member should teach per week:

Lecturer	15 credit hours
Full Lecturer	12 credit hours
Assistant Professor	12 credit hours
Associate Professor	12 credit hours
Full Professor	9 credit hours

The academic ladder for the PhD academic staff in Jordan consist of three ranks. Academic promotion leads to a considerable rise of salary. There is then no real incentives for researchers who have got the professorship, many of them switch to less momentum after this rank, so the professorship becomes the ultimate purpose and not the research itself.

Income of people involved in research work (most of the research in the country is carried out mainly at the universities) is relatively good, compared with those with other careers in both public and private sectors. 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.

Table showing the rate of salaries in the public universities in Jordan

Lecturer	J.D. 600-700
Full Lecturer	J.D. 800-900
Assistant Professor	J.D. 900-1000
Associate Professor	J.D. 1100-1300
Full Professor	J.D. 1400-1600

The average salary of some professions and public careers

Career	Salary
General Doctor working in the Ministry of Health	400 J.D
School Teacher in a public school	240 J.D
Army officer	400 J.D

[6] While some universities reward the one who carries out research by granting her/him a higher academic rank which entitles the person to receive a higher salary and a reduced teaching load and to occupy an administrative position inside the university, some universities punish those who do not carry out research activities by not granting her/him tenure. For instance, university laws state that a faculty professor with a PhD who does not get promoted from the rank of assistant professor into the rank of associate professor in ten years of service would be fired from the university.

INCENTIVES TO RESEARCH

Example: Initiatives of one University

(Extract from J. Gaillard, ESTIME Report on Lebanon)

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 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 programme), and *total funding for R&D for this academic year amounted to US$6,794,887*

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).

See also in the same Lebanon Report other sections:

Promoting research at Saint Joseph University (USJ)

Promoting research at the Lebanese University (UL)

INCENTIVES TO RESEARCH

Example: Structuring Research: the Tunisian Government

SCIENTIFIC RESEARCH SINCE 1987

The political change of 1987 gave second wind to the scientific research and technology sector by way of the setting up, in a primary phase in 1989, of the National Scientific Research Foundation and, in a second phase in 1991, of the State Secretariat for Scientific Research and Technology (SERST) attached directly to the Prime Minister's office. Its mission was to propose government policy on scientific research, see to its implementation and ensure its consistency with the options of development.

The Secretariat of State was reformed in 2001 into the Ministry of Scientific Research and Technology (MSRT) attached to the Prime Minister's office and since 2004 into the Ministry of Scientific Research, Technology and Competency Development (MSRTCD). The latter entity was given a new task, in addition to its ancient prerogatives: the

THE RESEARCH STRUCTURES

The policy law relative to scientific research and technological development allowed the restructuring of the national system of R&D notably through the setting-up of laboratories and units of research in the Public research establishments (PRE), Public health establishments (PHE) and the Higher Education and Research establishments.

The fundamental structures of research become: the laboratories and the research units.
The reorganization of the national system of scientific research and technological innovation allowed, up to the end of 2005, the setting-up of 139 research laboratories and 624 research units.

IMPLEMENTATION OF AN INCENTIVE SYSTEM FOR RESEARCHERS

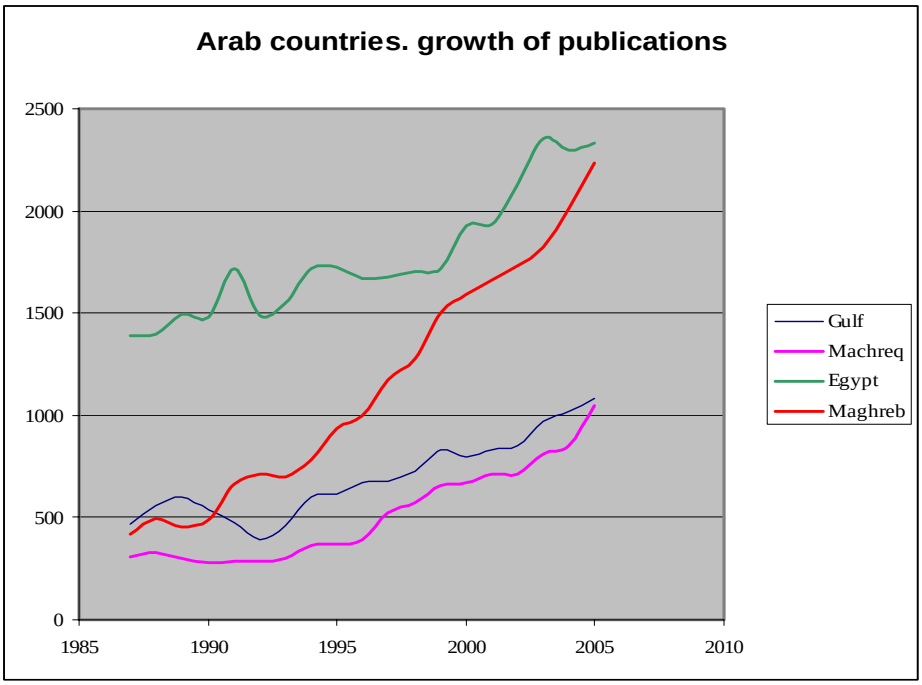
It was decided, in this framework, to set up suitable spaces, supply the necessary facilities and equipment, and recruit support personnel so that researchers could devote themselves effectively to their research work.
The level to which researchers are equipped with computers has progressed well, especially in the research structures where the objective is to have a computer per researcher.

As for financial incentives, it is noteworthy that the budget assigned for grants to third cycle students was doubled in 3 years, passing from 10 500 MD in 2002 to 20 000 MD in 2005.

The number of assistants under work contract among the third cycle students who have made good progress in their theses also clearly increased. These contracts can concern either a full-time or part-time education activity, or a full-time research activity in a relevant laboratory or unit or a higher education establishment, or a research establishment.
Moreover, the specific statutes regarding research officers and permanent researchers are being formulated.

OUTPUT

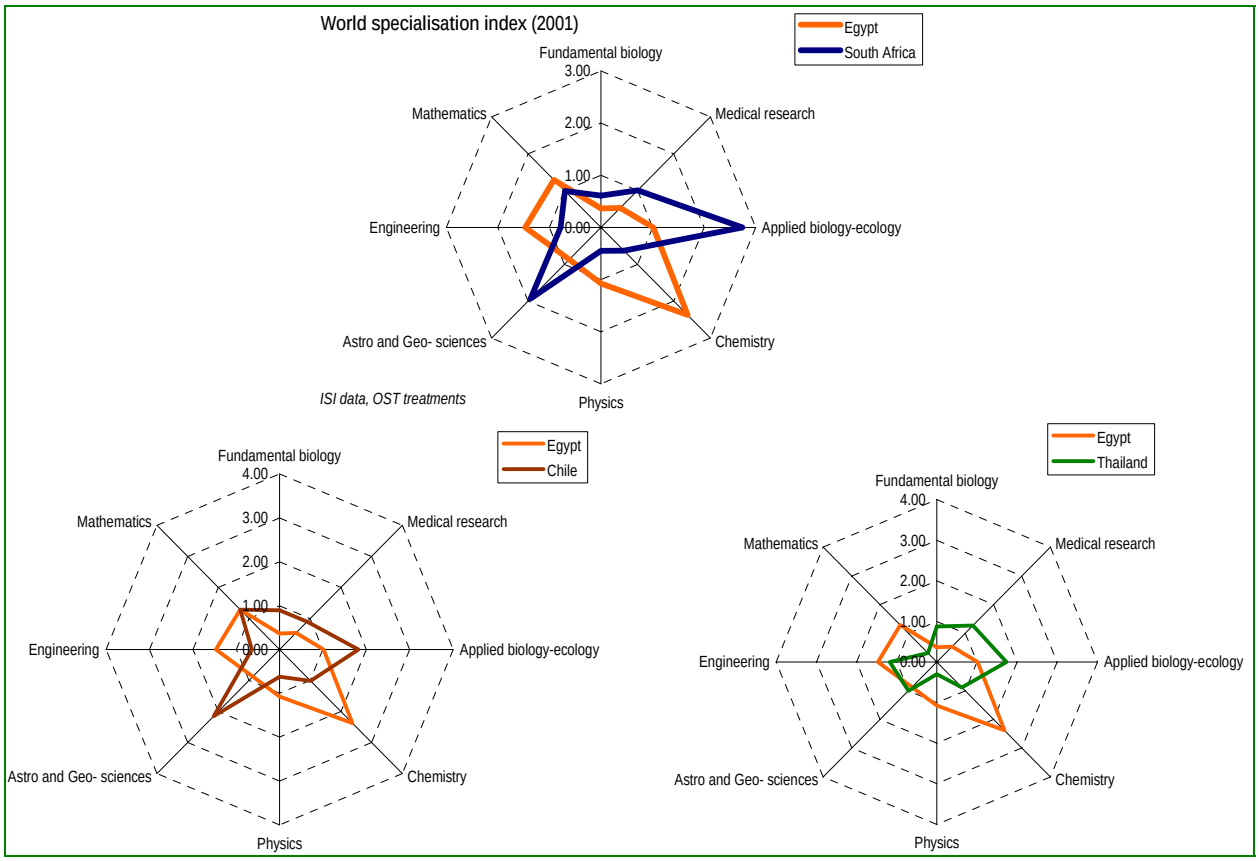
Growth of the publications (by sub region)



OUTPUT

Specialisation of the production

An example: Egypt compared to control countries



OUTPUT

Strong and weak specialisation

Strong and weak points. Life sciences

vert sur spé; rose sous spécialisation	DZ	MA	TN	EG	JD	LB	SY
Ecologie, environnement	1,12	1,1	0,98	0,79	1,55	0,9	0,32
Biologie végétale, Agriculture	0,62	1,57	0,95	1,25	2,06	1,1	1,83
Elevage, Pathologie animale	0,38	0,9	1,56	1,18	1,61	ns	ns
Alimentation & nutrition	1,06	0,54	0,53	1,76	1,46	ns	ns
Microbio, Viro, Maladies infectieuses	0,24	0,74	1,37	0,81	1,26	0,93	ns
Oncologie	0,09	0,13	0,19	0,3	0,24	0,83	ns
Endocrino & Appareil reproductif	0,47	0,16	0,7	0,39	0,3	1,6	ns
Médecine interne	0,21	0,44	1,59	0,12	2,23	0,8	ns
Gastro entéro & Cardiologie	0,12	1,39	0,88	0,47	0,3	2,4	0,16
Epidémiologie, santé publique	0,24	0,69	0,9	0,72	1,18	2,04	ns
Génie biomédical	0,82	0,9	0,79	0,45	1,7	1,71	ns
Biologie générale	0,32	0,61	0,81	0,24	0,08	ns	ns
Biochimie, Bio cellulaire & moléculaire	0,18	0,25	0,42	0,28	0,2	ns	ns
Immunologie	0,03	0,14	0,61	0,11	ns	ns	ns
Génétique; évolution	0,44	0,24	0,91	0,07	0,56	ns	ns
Neurosciences, neuropathologie	0,06	0,31	0,44	0,09	0,14	ns	ns
Médecine, diverses spécialités	0,21	0,61	0,12	0,36	0,28	ns	ns

Strong and weak points. Material sciences

	DZ	MA	TN	EG	JD	LB	SY
Mathématique & statistiques	1,87	2,99	3,38	1,09	0,8	1,43	ns
Physique générale & nucléaire	2,32	1,46	0,44	1,31	0,76	1	ns
Physique appliquée	2,58	1,81	1,96	1,17	0,64	ns	ns
Matériaux, cristallo, métallurgie	2,35	1,41	1,42	2,08	0,34	ns	ns
Autres (Chimie)	1,41	1,71	1,25	2,64	0,98	ns	ns
Chimie analytique	1,29	1,24	1,25	3,68	1,04	ns	ns
Chimie médicale, Pharmaco	0,44	1,49	0,19	1,65	1,9	ns	ns
Génie mécanique, Mécanique des fluides	2,74	1	1,22	2,07	3,81	1,1	0,54
Génie chimique, Polymères	2,61	0,56	0,93	2,62	1,83	ns	ns
Optique, électronique, Signal	2,16	0,63	1,1	1,15	1,12	0,77	ns
Informatique	1,25	0,87	0,84	0,76	1,11	1,13	ns
Chimie physique, spectroscopie	0,82	0,91	0,65	0,76	0,52	ns	ns
Astronomie, astrophysique	0,35	0,3	0,02	0,21	ns	ns	ns

Sources : Données SCI. Year 2004. Computing Waast & Rossi

Key : Green = overspecialisation. Pink = underspecialisation

SECTION 4: SUMMARY FINDINGS FROM THE COUNTRY PROFILES

We'll begin with a general view of the distinctive features of science in this part of the world : its historical setting, the status of knowledge and unsteady support to research, and the striking *diversity* between countries which will force us to distinguish sub regions and mention numerous exceptions.

In a second part, we'll differentiate two types of governance (centralized or not) and different strategies. We'll suggest that generally no *function* of its own is recognised to science, which makes for fragmented systems and calls for a top priority to the structuring of research

In the following parts, we'll deal with :

the institutional landscape (the role of a few establishments as sanctuaries for research, the responsibility of international cooperation in upgrading ambitions, the awkward emergence of scientific communities);

and with the situation of the human resources: the profession is not ill treated (with a few exceptions), but it is an easy target for a huge brain drain and researchers clearly need new incentives.

The output (which is growing, notably in Maghreb) relies on a small number of concerned people, working often in small teams and short networks. We'll present data about their specialisation, the achievements of human and social sciences, and the relations with the society and the productive world.

We'll then conclude on the hoped for institution building of a "research system", and the need to better monitor its achievements.

A. Distinctive features of the region

1. Historical setting.

In this region of very old and brilliant civilisations there are still powerful memories of the glorious past when science in the Arab states and Muslim Universities was much ahead of the rest of the world: in mathematics, chemistry, optics, medicine as well as philosophy and litterature. However, after ten centuries of a stormy history, the revival of science and technology in their modern form links up with an interaction with foreign imperialisms. They were brought in by the Ottomans in the Near East, by colonisation in the Maghreb. But they were only significantly institutionalized after the decolonization (which came in Machreq as soon as the 1940s, and years later in Maghreb[7]). It's not before the 1970s or often the 80s that mass universities and numerous research centres were set up and a visible scientific production began to grow quickly.

Egypt is an exception. Modern science and technology were naturalized in advance, to capture their power and preserve independence. Medical and Engineering Schools were set up as soon

[7] Colonisation assumed very different forms and lenghts, from a long populating occupation which lasted 130 years in Algeria and was overthrown through a fierce war, to short protectorates (30 years in the near East) or indirect rule (70 years in Egypt) ended through international negotiations..

as the 1820s and their alumni achieved technical feats (railway, irrigation…) that did much for the reputation of scientific professions. A private university was established in 1908 by nationalists, in order to mould a national elite. After independence (1922), it was confirmed as the (prestigious) public University of Cairo, which had been preceded by another private elite institution (the American University of Cairo). *As soon as 1928,* a Higher *Council for Scientific Research* was put in charge to propose, assess and encourage work in veterinary, agriculture and health sciences. It got a budget after the 2nd World War. And the 1950s saw the establishment of sizeable public *laboratories* for basic sciences within a National Centre for scientific Research and the Atomic Energy Committee. Universities also (Cairo and now Alexandria and Ain Shams) were keen to do research. Gradually the system grew and became a mass tertiary education apparatus. Polytechnics were founded (1950s & 1960s) then a new wave of Universities and Research institutes (1970s). Egypt can thus boast a long tradition in research, with decades of visible results (publications) and strong points (especially in engineering sciences, chemistry, and mathematics)[8].

No other part of the region can trace such a national scientific history. But some countries in the Near East have old and worthy *establishments* which go on playing a major role in their scientific achievements. They are mainly Universities. Two of them are in Lebanon (and private): the Saint Joseph University, founded in 1875 and which for long dedicated itself to Law, Economy and the training of local political elites; the second one is the American University of Beirut, set up as soon as 1867 and which at first specialized in more "technical" sciences (medicine and agriculture) for Arab clients of the whole region. The Damascus University is an old one too (set up in 1903)[9]. Elsewhere, the story of Universities is recent, beginning with independencies and aiming to train the managerial staff much needed after most of the colonial executives left. Few of these establishments became "research universities"; and this is not yet the case for many of the "young" and private Universities founded during the 80s or 90s (especially when they are market oriented, just aiming to meet the demand for skills and catch a number of students and fees as is often the case in the Near East[10]). At the same time, Research institutes (some of them inherited from the colonial powers) have been repopulated with national scientists and there was a vogue for their creation in the 1980s and 1990s (especially in Maghreb).

In all cases Maghreb (due to a late colonisation) was clearly behind Machreq at the beginning of the 60s, and Machreq and the Gulf behind Egypt. But the main institutionalisation of science remains everywhere a recent one (dating back to 2 or 3 decades).

2. Social Environment

Even when there is a long tradition of research (Egypt), the social inscription of science remains unsteady. The societies are strongly framed by communities, lineage relations and religious belief. Furthermore, the political sphere is dominant. A resounding report from UNDP, written by authoritative experts from the region[11], recently marked out inadequate

[8] Egypt too is since a long time a vibrant place for "Human and social sciences" (teaching, research, publishing, ideological debate) with establishments as the very old and prestigious University Al Ahzar, and intense moments of philosophical, political and religious creation.
[9] Algiers University was established in 1903 too. But it never trained any significant number of "Muslim" students.
[10] Maghreb universities are less market driven and most of them do some research and built strong points in specific areas.
[11] UNDP. Human Development Reports: Arab countries.

relationship with knowledge as one of the two or three main handicaps hindering progress in Arab countries. They blamed for it the spirit of both school and family education (influencing the very style of scientific activity and making little room for creativity), and the status of knowledge (held in low regard – in societies dominated by political and lineage values). A number of monographs insist on the fact that common values play down the worth of knowledge (except for the religious one) and discredit efforts to widen it. Jordan is a well documented case.

> "The social understanding of science considers obtaining a PhD degree as the end of the process of reading and researching. The degree rather than the record of scientific research is what gives the person a social status in the society (and even in the university). The social view that sees the university faculty as capable of exercising certain forms of social and political power encourages many people to seek for his assistance. Family and neighbours of the researcher regularly visit her/him in the office on campus to ask for some favours and services. The position of the researcher within the social power network and her/his ability to exercise power within this network are for him a permanent concern.[12]"

Maghreb is somewhat different, as research has become part of the role model of respected *professions* (or of their recognised elite: academics, professors of medicine and high flying engineers). Nevertheless "multiple irregular commitments of other nature prevent the researcher from concentrating on his research and from spending continuous time to process the data". In all countries, "social factors play a big role in impeding scientific research or limiting its efficiency".

3. Support to Science

Amidst adverse context (insecurity and political unrest could often be added) science grows nevertheless. It can't be so without entering into alliance with social groups, which see their own position and struggles in the society as analogous to those of science in the world of knowledge. Thanks to their support it becomes possible to go round the obstacles and devote to a scholarly life.

Among these "socio cognitive blocs" the main one is that linking *the state* (or fractions in power) with the cause of science. Either as a symbol of modernization (Gulf), of rationality (Tunisia), of uniting the people under a nation state (Syria), or because it was part of the development model (Nasser: Egypt) many governments at one time or another granted strong support to the blossoming of tertiary education and research (especially in "hard sciences"). It should be stressed that such a support can't be taken for granted. It depends on the regime, the fractions in power, and there were indeed many turnarounds.

> Algeria is a good example. While it paid little attention to University and none to research after independence (concentrating on primary and secondary education), it promoted vigorously a "scientific option" after 1975. A number of Polytechnics were opened, Universities of S&T created, enrolment grew quickly, and a national body for driving research (ONRS) was granted a large budget. These efforts were due to the weight in the government of a faction of "technocrats", who tried to launch a heavy industrialisation of the country in order to make it independent and prepare the post petroleum era. Their opponents were "patrimonialists", who considered there could be no autonomous development before the recovery of an authentic culture (original language, religion, values…) and put priorities

[12] ESTIME Project: Jordan country report: www.estime.ird.fr

elsewhere. The development of "Science" was objectively linked to the first ones[13]. When they lost their footing (after 1980) scientists lost their credit, many of them had to leave the country, swirls affected the governing bodies of research and budgets were severely cut. It is only since a very few years (at the end of the civil war) that a new strong effort for research has been scheduled, with striking results, by the current modernizing government.

A general characteristic of the region is that the support of the state may be powerful, but it has *ups and downs.* In many places it is discreet (Machreq and the Gulf) but it should be acknowledged that almost everywhere the state did a great deal for research through regulations (especially the subordination of promotion in academic careers to some research work); and with few exceptions (Egypt and Algeria), governments never ill-treated the profession.

An (alternative) support for science lies in *professions*. This is notably the case again *in Maghreb*. Professional groups, that did not exist before independence, have developed quickly. They maintain proudly high standards and they have integrated research into their role model – offering shelter to researchers when the state support weakens (See Waast for medical practitioners, Khelfaoui for engineers and for academics) [14].

Another support may come from outside. *International* pressure and advice have been instrumental to set up governing bodies and adopt favourable regulations[15]. International scientific cooperation helps keeping the scientists up to date and supplements finances. In some disciplines, international demand for research gave rise to a recent outburst of (private) research "Centres", and employment in that branch. This is typically the case in Machreq, for social sciences.

Finally, one can identify a support from specific communities or social groups (liberal elites in Egypt and Lebanon, important families in Gulf countries, technocratic strata in Algeria…). This is idiosyncratic but matters a great deal locally (grants, political support…).

All these supports are important. But none is decisive or really stable. Finally, the visible growth of results *stems from the professional norms* internalized by a few individuals and some establishments that maintain a research culture. As we'll see they need new encouragements.

4. Diversity: 3 Zones.

We already identified some common features. It should be now recognized that there is a great variety among Arab countries. Their relative identity stems from a common language, the dominant religion and the joint heritage of ancient arabo-islamic civilisation. Their unity is more of a cultural and symbolic nature and does not rely on institutional substance.

History, economics and the different regimes have carved distinct zones. Even neighbouring countries in this region have a different endowment in natural resources and their own

[13] El Kenz, "Prometheus and Hermes" in Shinn, Spaapen & Krishna *Science and Technology in a Developing World*, Dordrecht:Kluwer1997:323-348; for Tunisia see Siino "Tunisian Science in Search of Legitimacy" in *Science, Technology & Society*, 8 :2, 2003, 261-281

[14] Waast "Médecine recherche et protection sociale" in Curmi ed. *Médecins et protection sociale dans le monde arabe* Cahiers du CERMOC, Beïrut (1993): 83-99. Khelfaoui "Scientific Resaerch in Algeria: Institutionalisation versus Professionnalisation" in *Science, Technology & Society*, 9 :1, 2004, 75-101

[15] They also helped to create "Mission Centres" in fields of world-wide interest (geophysics, epidemics, etc)

development strategies (past and present), which make them very diverse. This bears upon their very attitude toward science and education. In broad outlines, one may distinguish ***three main zones*** (with a lot of variations inside): the Gulf countries Machreq and Maghreb. Egypt is a case by itself.

* As soon as they were independent, most of the *Gulf countries* adopted an "anglo-saxon model" with elite universities, and research programs in experimental sciences (widely open to collaboration with foreign countries – mainly USA and UK). In human and social sciences, research programmes were on the contrary "closed" (reserved for local language and scientists). In both cases a pragmatic science expanded, connected to local problems: chemistry, biotechnologies, computer science; sociology (in fact social engineering), micro economics, and Islamic philosophy or law. Research is not here of real need (for the economy depends on royalties from oil and linked remittances[16]), but rather the vestment of Universities (and an ornament for donors). It has been funded by some states, and numbers of *Foundations*. It is mostly operated by foreign professors, sometimes by prestigious invited visitors, who were hired in greater and greater numbers as the Universities increased significantly.

* *Egypt* (and other countries in the Near and Middle East like Iraq or Syria) set up soon a mass education system, including tertiary education, with a view to train the technical workforce needed by their development model (mass production for internal market). As this "Fordian" model failed they entered hastily in a reconstruction of the education system. Private Colleges and Universities proliferated[17] while the public establishments, overcrowded and ill funded, lost quality and their staff suffered a drop in status and wealth (especially in Egypt). A number of academics and researchers left (at least temporarily) to the Gulf countries (where there was a growing need and good pay for their skills) and / or concentrated their activity on consulting and expertise[18]. National Institutes (outside Universities) are important performers here. But their budget was reduced and they have now to become more and more self-financing. This rule is imperative for the research centres established by the main Universities in their own walls. They too have to get funded by external contracts. These new dynamics altered the academic hierarchies and disciplinary requirements for the benefit of networks based rather on patronage.

* In the *Near East* (Jordan, Lebanon) though no "Fordian" ambition prevailed (their internal market is indeed too small) the *private spirit* was sooner most pre-eminent. Most Universities are private ones (since the 90s in Jordan, and long ago in Lebanon, where the only public one – "Lebanese" – gathers half of the students but was set up only in 1950, one century after the first private and prestigious establishments). There are almost no national research Centres, except small ones in very specific areas (seismic survey, transport). But University laboratories depend on private Foundations (and make a living on contracts, manly delivering services or development research, rather than applied or strategic ones). Recently, a host of "commercial" research centres were created in social sciences to meet the important demand of studies by international bodies (UNDP etc about the Palestinian camps and integration, political situation etc). Here, research should be clearly marketable. Other norms for it are

[16] As some of these countries are preparing for the « after oil » era, they turn to an economy of trade and services rather than to innovative industry. They are not in need of more research (at least in hard sciences, if not in economics and modelling mathematics, which gain ground).
[17] Except in Syria.
[18] Meeting the new demand of international bodies and enterprises (World Bank, Occidental Foundations in the social sciences; Pharmaceuticals and computer industries…

only maintained in a few establishments, bringing up their honour (and providing a label which attracts students and financial resources). These are a few "research universities" (like AUB in Beirut or JUST in Jordan) or reputable Foundations (like the Royal Scientific Society in Amman).

* *Maghreb* is different. Though latecomers, Morocco, Tunisia and Algeria established quickly mass universities of quality throughout the country (after 1985), and a number of prestigious Polytechnics (selective, for all sorts of engineers). They set up in parallel national Centres for research in various fields (agriculture, health, and later telecommunications, energies, nuclear technology or materials). Their model (institutional and intellectual) draws inspiration from Europe (especially from France) and intensive scientific cooperation has unfailingly supported their activities. State control is strong; governments are secular and nationalist with a technocratic ethos. They launched and financed the system (though through eclipses) without the private sector managing to carve a significant share of the activity. Scientific talents and vocations are not lacking, and research soon professionalized. There is some R&D in enterprises (more so in large state owned ones, especially in Algeria). Innovation and technology are values among the high technical civil service and research (pure or applied) is part of the role model of academics[19]. There are variants in this sub region. Tunisia was most constant in its support to science, and has recently developed a full set of institutions framing research, which is lacking elsewhere (See next section).

B. Governance and Policies

National bodies caring for research appeared much after the performers. The first Universities came into being at the latest by the 1960s[20] and Centres often beforehand. On the contrary, the first national authorities (or dedicated bodies) date back to the 70s (Algeria, Tunisia), or the 90s if not the 21st century (Syria and the Gulf)[21]. The establishments had time to forge their own culture and management of research (or non-research).

By now, it is possible everywhere to identify some higher body specially concerned with "Research". This does not imply that they worry with elaborating policy documents. Some countries did it (especially in Maghreb). Morocco and Lebanon even elaborated "visions" for the long term, involving a number of stakeholders in debates that lasted for more than one year. Those briefs are instructive. But they very often reflect the on going state of the economy, the societal needs and the government concerns of the day. They rarely lean on a detailed knowledge of the scientific capabilities established in the country, and an imaginative distinction of the opportune niches that could be derived from them (considering the global technological stakes). They need to be translated into strategies. This is why they are often replaced by action plans, or a mere enumeration of "priorities" (Gulf countries).

Instead of holding forth on these texts (and the way they are drawn up) we think it more useful to insist on three points:

[19] Their carriers are linked to achievements in this field.
[20] Much before in Egypt and Lebanon, which are exceptions. But later (in the 75s) in some Gulf countries.
[21] See Descriptors. Egypt and Lebanon again came earlier.

- there are two different approaches to the governance of science
- they lead to different strategies
- in all cases the function of science remains questionable, and the research system is fragmented.

1. Centralised governance or grassroots initiatives.

There is a great difference between two main approaches. In (Egypt and) the Maghreb, there is a strong role of the state in the management of the research sector. There are policy documents. An interministerial Committee meets more or less regularly (at least once a year) to specify the strategy. A permanent Authority (a Ministry or Ministry of state, at least a special Department[22]) translates them into regulations, legislation, institution building, budget grants and instructions to the establishments. Its arms (Agencies or National services) take action, implement the measures and monitor the situation. The state created most of the establishments likely to do some research (Universities, Centres), specified the status of their personnel (who are mostly civil servants) and keeps them all under control. Government funding is the main resource for research (either core funding to establishments, earmarked or competitive funds that now spread). Moreover, it can be said that impulse from the state is waited for by the actors and not only an approval for their grassroots initiatives. This pertains to guidelines on priorities, as well as encouragement to research. This government method has clear efficiency (general impulse, synthetic plans) as long as the state remains strongly committed; but it may cause pernicious effects (like a bureaucratic spirit[23], little initiative of performers and poor networking with local actors – non academic). This governance mode can be depicted rather faithfully through organisation charts like those of Algeria or Tunisia (See the Descriptors Section).

The second approach is quite opposite. It prevails mainly in Machreq and the Gulf countries. The *performers* are most important (Universities, enterprises – there are few Research Centres here). Activity relies on their initiative and on their decision to take part or not in research, according to their own interests. National bodies in charge of science are often independent (though their budget almost totally comes from the government). They are supposed to act by persuasion on the basic actors, through incentives, services and working as facilitators.

> In Lebanon, the "CNRS" (National Centre for Research) is a public Agency under the authority of the Prime Minister. It was created as soon as 1962 to become the umbrella of four (small) research centres.[24] But it also gained a mandate to "draw up the general outline of a Lebanon's National Science Policy and *advise* the government". Its implementation role is to "encourage" research activities through work programmes formulated "in cooperation with the appropriate ministries and the private sector". Practically, part of its budget has been devoted to calls for projects, addressed mainly to the Universities and open (not oriented)[25].
>
> In Jordan, the Higher Council for Science and Technology (1987) is entrusted with a policy making mission and a role of implementation. Its independent budget allows it to support research and development projects and programs. Its board is a sort of interdepartmental Committee. This structuring looks like a centralised one. However negotiations with the

[22] Generally in the Ministry of higher Education – but often too in other ministries such as Agriculture, Health or Industry and Mines. The national authority may be scattered, reflecting the fragmentation of the research system.
[23] Khelfaoui (STS 9 :2) speaks even of an « authoritarian control » "crippling bureaucratic impulses" and for Algeria of a « military style control over scientific institutions".
[24] Geophysics, Marine Sciences, Remote Sensing, and the new Lebanese Atomic Energy Commission.
[25] It should be noted that this budget represents only half of the own research budget of the leading Universities (St Joseph and Lebanese) and one fifth of the research budget of AUB.

performers are very important; for the main thrust is on R&D (rather than S&T and University science) and on supporting technological learning in the local enterprises.
"Practically, no specific strategy for research is available at the level of local institutions. The Higher Council for Science and Technology is attempting to establish such a strategy, but the selection of research topics generally starts with the identification of a problem by individuals, followed by preparing a detailed proposal (objectives, methodology and requested resources). Depending on the scale of the project and the requested budget, the proposal is either submitted to the institution itself[26] or to other funding agencies (i.e. UN agencies, US aid and EU)".

The most remarkable bodies can be found in the Gulf countries. They are generally very new, and they consist in Agencies or Foundations whose objective is in particular to attract foreign capabilities and R&D firms from abroad. This of course does not prevent a Ministry (of Tertiary education) to assume "governing functions (Bahrain)" i.e. "approve foreign degrees" (Emirates), or "keep track of scientific research undertaken by colleges and institutes of higher education (Kuwait)". But in Kuwait, KFAS (the Kuwait Foundation for the Advancement of Science, whose board is a sort of interdepartmental Committee) is a more important player. It has to provide "funding and coordination for the research", seeing to "the investment of the results in extending development to broader and newer horizons" with the private sector as a main target. The Qatar Foundation was instrumental in attracting prestigious foreign institutions of higher education[27]; and the Qatar Science and Technology Park (QSTP: the other major R&D public organization) is a "home for technology-based companies from around the world, and an incubator of start-up enterprises". Emirates are most active along the same path, negotiations being directly driven by the government.

Egypt has a mix of centralised governing public bodies (in fact several of them: a Ministry, the Academy of Sciences, without reckoning other Ministries) and of some powerful performers (like the National Centre for Research, and various prestigious (AUC) or huge Universities – Cairo University being the largest). Governance is complex.

2. Different strategies

The difference between governance modes leads to different strategies.

For Maghreb countries (and Egypt) there is a clear awareness of the necessity to develop first a solid *national science base*. This means first basic science (and they have developed a whole range of capabilities in all sorts of specialties in hard and engineering sciences) then drawing it toward applied or strategic research (sometimes in specialised Centres) and linking it to the productive sector. Significant efforts have been spent to this end and numerous mechanisms are on trial. Algeria recently put a lot of money in PNR (National Programmes of Research) in order to attract its scientists into applied projects. Calls for tenders were also used in Morocco. Incentives for enterprises try to encourage them to invest in R&D and link with research performers. There is now the full battery of instruments recommended by international bodies to develop innovation.
Yet, some observers underline that "a real research activity is linked to the emergence of a scientific community, and results of a professional rather than an institutional development" (Algerian case: Khelfaoui, 2004: p. 86). This is of course the most delicate challenge for a centralized governance.

[26] To the Dean of Scientific Research if this takes place at University.
[27] "Campuses of Carnegie Mellon, Texas A&M, Weill Cornell and other leading universities were created.

In Machreq countries, there is not such a difficulty. On the contrary performers are free of their initiatives (and very often let alone with their own means or unwillingness to take part in the game). The "authorities" have to make the most with their good fortune, namely the specific capabilities existing in the few establishments interested by research and ready (by chance) to be mobilized. The asset is not always in line with the expectations of a coherent Plan and the strategy is rather to launch open calls for tenders to find out the potential or/and to test it through pragmatic projects.

Through this process, national authorities "enter a market": they experiment the competition with other (international) donors: for the number of research volunteers is limited, and they reach a saturation point[28]. Human & Social sciences are a special case, as a number of "commercial Centres" and research NGOs emerged to enlarge the offer and meet the large foreign demand in Jordan and Lebanon. As equipment is needed this is more difficult in experimental sciences. In any case, developing a national research strategy is not an easy task for authorities.

The Gulf countries are an extreme case. Their own strategy does not aim at building on a national science base; but at *localizing on their territory the best foreign* capabilities, and innovative R&D firms. Qatar has attracted campuses of Carnegie Mellon, Texas A&M, Weill Cornell and other leading universities. Emirates had no less success with Abu Dhabi chapter of the Sorbonne, University Wollongong or Westfield University (not counting the brand new American Universities of Sharjah). They are building giant premises for next "Knowledge Universities" (a multi university complex in Dubai).
First members of the Qatari Science park were "EADS, ExxonMobil, GE, Microsoft, Shell and Total. By bringing research and business together, QSTP is delivering Qatar's vision for a knowledge economy". Emirates again established in 2003 a Knowledge Village (KV) in the Dubai Free Zone for Technology and Media. It houses more than 200 companies and institutes for training and education in fields such as computing, technology, business management, life science, fashion and media". A Dubai Academic City (DAC) is marketed as 'a *new global fully integrated academic destination*'[29].

This is an innovative strategy, looking ahead and fitting small countries. It looks like that of Singapore days ago. This is a shortcut to the building of a national science base. Links could be later interwoven with local performers. The main question is whether this new strategy is a sustainable one; or a purely commercial (and rather: financial) one. New campuses are designed to compete with the best old Universities in the region (AUB…) and elsewhere. They are supposed to attract a number of rich and brilliant students[30]; and their assessment is by now much more in terms of profitability than of substantial contribution to education and knowledge. The same is true for R&D firms: no substantive industrial strategy is yet linked to their arrival.

[28] See Lebanon monograph. The competition is illustrated by the research budget of a prestigious University (AUB) and its sponsors. Same monograph.
[29] "It was officially launched in 2006. Investment in this phased project, which is being built on a 12- million-square-metres campus, is forecast to exceed Dh12 billion (US$3.27 billion). A completion date is set for 2012".
[30] In the Knowledge Village, "25 percent of the students are from countries in the Middle East, whilst other students are from Arab and foreign communities residing in Dubai".

3. Structuring research.

Finally, a similar problem arises whatever the governance system. Is there a "research system", fitting a specific *function*? Can we compare it to e.g. our breathing or locomotive systems fitting specific functions in our bodies? Such systems consist of specialized organs, interrelated (if one of them fails, the goal is missed), linked up to a coordinating centre through a network of channels conveying continuously instructions and information. They are capable of auto correction and working towards a permanent own goal.

In Arab countries, one can say there are organs for research (Universities, Centres, and sometimes an overabundance of more or less governing bodies) but they don't make a system. This leads us to ***the structuring of research.*** It exceeds probably the prerogative of establishments. As far as research relies mainly on their taste for it, the "system" is fragmented (indeed there is no "system"). There are any numbers of initiatives, around small and scattered projects rather than programmes, and they are not coordinated.

> In best cases there is an undying dispute between "excellence" and "relevance": the first one being claimed as their flag by academics, and the second by Centres, Polytechnics and engineers. This is what happened in Tunisia for decades[31], against realities (much applied research in universities, and few clients for the technological offer of Centres); and without making much neither for the advancement of science nor for its cause by the general public and by the productive sector.

This went on until (10 years ago) *the Tunisian state* considered research as a specific goal and set up a whole arrangement of institutions. It is the most complete in the region and *certainly a good practice*. The critical step consisted in establishing the building blocks of a specific system: "research units" and "laboratories" meeting a strong list of criteria (size, skills structure, proven results) accredited and periodically *assessed* by international commissions. These teams may be bound to a University, or to a research Centre, or cross over the different sectors. They must have a research plan, and they generally combine strategic and applied research. Linked to their accreditation are benefits in kind[32] for their directors, special access to up to date documentation and equipment, and a significant long term core budget. A special state supervision has been instituted for research (directly linked to the Presidency) with growing budgets (now more than 1% of GDP). A number of other institutions were established: an interdepartmental Committee, a national *Commission for assessing* individual researchers, a national Plan stating priorities where important means are invested (telecommunications is an example), incentives for R&D in enterprises and joint funding mechanisms with the productive sector. Of course this system is restricted only to a (small) part of the theoretical scientific potential. Figures of FTE may seem to have declined, but *active researchers* only are counted (as in Mexico and other Latin American countries). The result has been a spectacular and unfailing leap forward of the output[33].

> Other countries of Maghreb have recently taken similar paths but in a less comprehensive or systematic way. There is not only one structuring model. Good practices may begin at a smaller scale and result from limited initiatives by establishments (AUB in Lebanon), Foundations (RSS in Jordan) or international cooperation (through long standing support to research units). The important thing is that research be considered as a permanent function, and that researchers no longer be atomized individuals. Institution building is necessary to strengthen long lasting laboratories that enter into large-scale networking and ambitious international programmes.

[31] Siino "Tunisian Science in Search of Legtimacy", *Science Technology & Society*, 8:2, 2003, p. 261-281
[32] Mostly : reduction in teaching or routine work load.
[33] Tunisia is now 2nd in Arab countries, after Egypt but outmatching Morocco.

C. Institutional landscape

The previous chapters gave already some hints of the institutional landscape. Indicators and descriptors are enough to indicate the main operators. They are either Universities (now in great number everywhere) or "mission Centres" (important in Maghreb and Egypt, much less in the Near East)[34]. The staff of these establishments is rather well known. Difficulties begin when one tries to measure the "full time equivalent" committed to research. Monographs dealing with that task get to very different results. This is not a question of definition, but the expression of a structural embarrassment.

1. Research: a subordinate function

Institutions were created for specific missions: Universities for training civil servants (and later, other managers and executives); Institutes and Centres for monitoring sensitive spheres (such as agriculture, mines, marine life and fishing, energies, etc.). For them all research is **a *subordinate function*.**

If we look first at *Universities*: research is *not* on the agenda of the most recent and private ones[35]. Among public establishments, only a few practise researches; within the "research oriented" ones a small portion of the academics is regularly producing results. This is well documented through bibliometric studies.

> In Jordan for example, two thirds of the publications come from two public Universities (Jordan and JUST). In JUST only 5 areas of research are very active[36]. And in these areas, production rests on small groups of 10 to 15 people of whom 3 or 4 are authoring 25 % of the articles. This means that 5 to 10 % of the academics are intensely active in research, authoring half of the publications (in Jordan: 600 out of 6 000 academics). A similar evaluation in Maghreb shows that about 20 % of the academics were steadily active in 2002, and they authored half of the publications.

The mainspring linking (sometimes loosely) career to research achievements is not sufficient to supersede the fact that research is considered as a minor function of the University (or not a function *per se*) with its correlates: many establishments have no strategic plan for research and very small budgets for equipment, documentation or project operating. They often ignore their own capacities and their laboratories (if there are) are not mentioned in their web pages.

In the *Centres*, time and budget for research generally come after routine surveys (coastal pollution, replenishment of fish stock, earth tremor…) have been organized and maintained, and a number of services operated (production and distribution of seeds, vaccine production, nuclear waste gathering…). This is time consuming for engineers and researchers, occupying fully a number of them[37]. Often, research is limited to little creative development. Very rare Centres are totally dedicated to research and basic sciences. A notable exception is the National centre for research in Egypt (with 2 000 researchers). Some other centres practise

[34] Universities are rather autonomous (more than the Centres, under the supervision of various technical Ministries). All these establishments are consistently resourced, sometimes with highs and lows, but never without any operating funds – as the case exists in Africa, and in some countries of Latin America (Andine countries) or Asia (Bengla Desh).

[35] With the notable exception of 3 the old elite and prestigious ones: St Joseph in Beirut, and American Universities (in Cairo and Beirut).

[36] Out of one hundred possible in a full breakdown of scientific fields. See ESTIME project, Bibliometric report.

[37] Sometimes, a research plan acts as a safeguard to preserve this activity (as in INRH, Morocco).

significant “strategic” or applied research (notably in Egypt and Maghreb). Most of them are small or medium sized institutions: when it comes to making contributions to science other than simple engineering the question becomes that of the critical mass available for a long term effort. Alliances (with academic research among others) would be necessary. But the Centres often prefer in-house operation, in order to keep control on the process and their own staff. They are reluctant to enter into cooperation (except international).

2. Sanctuaries for Research.

Thus, much depends on ***the management and culture*** of the establishments. Research needs sanctuaries, and some places offer it a shelter.

It must be stressed that very few private centres have been set up outside official institutions (except in human and social sciences). This is a strong difference with Latin America, where it’s a sort of model when fiery and talented key figures endeavour to launch a new field or create a space for science. In Arab countries research is mainly reinforced through appropriate initiatives in the establishments which already decided to gamble on a research label. A good example is that of old and elite Universities in Egypt and the Near East. Another example is that of Polytechnics in Maghreb, a number of which built their reputation on their research creativity: IAV-Rabat (in Agriculture and Veterinary Sciences) and now INTP (Telecommunications in Rabat, where more than half of the years are pre-recruited by international firms even before they get their certificate). These are excellent examples, though others could be mentioned.

A number of “good practices” are worth being mentioned. In Morocco, all the Universities are now obliged to appoint a “Research Dean” and to submit a “*Research Plan*”, opening rights (if approved) to specific funds from the State. A number of Centres worked out a strategic plan for research. Some Centres have developed teams of academics and in-house researchers who get access to superior equipment to achieve joint projects (Social sciences in Algeria, Nuclear Centre in Morocco, numerous examples in Tunisia).

Other solutions are more personally oriented. Prestigious Universities in the Near East have established a “Bureau” (as AUB in Beirut) helping closely the academics to apply for research contracts and manage them. Moreover, tenures are rare and work-contracts are renewed each 4 years only when applicants produce proofs of research (AUB again). At the Lebanese University, the research budget of the establishment was converted into an individual bonus for the staff who submitted their current projects to a scientific Commission and proved they have results.

The objective is to develop loyalty of the staff to local research structures, even if a national structuring is not yet established.

3. International cooperation

International cooperation plays a great role in this context. Because here research has a subordinate function, it is often pursued on an individual basis, or within small teams and short networks: all the more when its motivation is obtaining a thesis or boosting a career through personal achievements. In order to enlarge the “critical mass” necessary to carry out the task (Centres), or to gain access to an equipment and documentation up to date (Universities) the researchers seek often the cooperation of foreign colleagues or laboratories.

This is also a way to avoid insularity, expose to new concepts and hot topics, publish abroad and get some additional funding (especially for travelling and taking part in the world science). Bibliometric studies show that a large proportion of articles are co-authored with foreign researchers: roughly half of them in the Gulf countries and Machreq, and two thirds in Maghreb[38]. Egypt is an exception : its large scientific potential has been working for long in self-sufficiency (80 % of the publications up to 1990); it is now rapidly opening to co-authorship (1/3 of the articles in 2006). Lebanon drifted from a quarter to a half of foreign co-authorships in the last 8 years; Jordan doubled their proportion. An underlying limit for all could be 50 % of co-authorship with foreign countries[39].

Such abundance of cooperation[40] 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 programmes without grasping all of their stakes (economic or scientific). There are examples of well positioned activities (Neuropathology in Morocco, Drugs chemistry in Egypt, Energetic engineering in Jordan etc…) supported by top quality cooperation. But maintaining anticipating niches (promising short cuts to discovery or/and original innovation) needs a vivid imagination and large scale collaborations. Quite the opposite, detailed bibliometrics shows that most collaborations are going on between small teams and through short networks[41] - most often on the occasion of projects, not programmes.

One of the main weaknesses of most Arab research units is their lack of participation in ambitious and far reaching programmes. This is not impossible even in very sophisticated fields. Examples are high energy physics in Morocco, linked to the ATLAS European project; or indigenous genetic diseases in Maghreb – through French high flying collaborations. There is a specific responsibility of international cooperation on this level. Small bilateral projects lead to sustaining (and even building) capacities: but hardly to institution building.

4. Scientific communities.

Attention should be paid to the signs of a ***scientific community*** getting shape and strength. Among these are frequent Conferences and seminars, the flowering of scientific journals, circulation of scientists, and the activity of learned societies, professional associations and academies. Most of these institutions are lively in the region (though often short-lived and constantly re-formed). Egypt and Lebanon are active centres for publishing houses (especially in social sciences) and Kuwaït has become a major place for scientific journals (especially in Arabic language). Intellectual circles are popular in the Near East, as well as the expression of learned peoples in magazines and other media. The Maghreb countries have a more discreet publishing activity (except Morocco); but they are vibrant regarding associations. Networking and face to face contacts are dense. It must be stressed that a number of conferences and societies have a (sub) regional dimension (either of Machreq or Maghreb standing; Egypt and the Gulf joining sometimes with the first ones). But this rarely ends up in co-authoring articles or participating in joint projects.

[38] Only 50 % in Tunisia.
[39] To be compared with 25 % in Asia and USA, 40 % in Latin America, 50 % in sub-Saharan Africa (and more in some countries of this region).
[40] The main partners are European countries (first partner when counted together). France is very active in Maghreb (also in Lebanon and Syria); UK and Germany are oriented toward Egypt, Machreq and the Near East. USA are the first individual partner in Egypt and east of Egypt (very little in Maghreb).
[41] See ESTIME : Bibliometric Report (especially: Atlas of institutions and study of networks)..

D. Human Resources

As the national interest in scientific creation is not precisely worded nor continuously expressed, much depends on the initiative of establishments, and in the last instance on the readiness of individuals. The role of professional norms and values is here very important, together with the bent of individual persons.

1. Profession

Profession remains attractive. Academics (and to a lesser extent researchers) were ***not ill treated*** in that part of the world. In Morocco (and even Tunisia), in Lebanon and Jordan faculty members are well remunerated[42]. The following narrative sets out the present state of things in Jordan.

> Income of people involved in research work (most of the research in the country is carried out mainly at the universities) is relatively good, compared with those within other careers in both public and private sectors. However all public universities have (more or less) similar scale for salaries which mainly depends on the professional rank of the research staff (assistant professor/researcher, associate/professor). Research staffs that work on large-scale projects and get involved in some administrative work usually get paid for such extra efforts.

Rate of salaries in the public universities in Jordan

Lecturer	J.D. 600-700
Full Lecturer	J.D. 800-900
Assistant Professor	J.D. 900-1000
Associate Professor	J.D. 1100-1300
Full Professor	J.D. 1400-1600

Average salary of some professions and public careers

Career	Salary
General Doctor working in the Ministry of Health	400 J.D
School Teacher in a public school	240 J.D
Army officer	400 J.D

> Salaries in private universities are higher than in public universities, so a migration of researchers from public universities and institutions into private ones, for financial issues, can be noticed. However the researchers acknowledged that the public universities have noticed this issue and have reacted and modified the salary scale accordingly in order to retain their expertise[43].

Salaries in the Gulf countries are even much better. Exceptions are Egypt and Algeria. There, the remunerations were dreadfully eroded by price rise. An important emigration takes place

[42] In Morocco, one should count the different bonuses linked to the function, as the bonus for teaching at university and the "research" bonus served to any academic – whatever his activity. This was a way to increase (= double) the remuneration while all public salaries were theoretically frozen by "structural adjustment" plans. It must be taken into account that academics are all the more respected they are numerous and close by possibly turbulent students. This is not the case for researchers, whose professional status is often less advantageous and who try to line up with university members.

[43] See P. Larzilliere, Jordan Country report, ESTIME, 2007.

continuously. And professionals are often busy with parallel tasks (contracts for teaching or doing research elsewhere) to make their living[44].

Careers are regulated by research achievements. An important feature is that promotion at University is linked to research results. Though this demand may be loose (number and quality of publications required, in-house assessment) and can be circumvented it served as a powerful spur to practise research in Morocco, Algeria, Tunisia, Jordan and other countries where the public tertiary education is substantial and pre-eminent. This is a handy way for regulating the careers: not a proof that research became a major function in Faculties. It was adopted at least in Maghreb and in the public establishments some thirty years ago when a first status was carved for academics. The same is true in Egypt and Machreq (public universities). [45]

Research is part of professional role models

Fortunately, there are other motivations to do research. They stem from professional models and internalized academic *norms and values*. Young academics and researchers have been trained (as doctoral or post doctoral students) within demanding laboratories (often abroad). While spending some time in Diaspora or through cooperative projects, they always remain in contact with international standards. In this process a number of them acquire strict scholarly norms and values.
Moreover, within specific professions (medical practitioners and engineers are well documented cases) research is part of the ***role model***. These professions have respect for the reliability of conscientious and persevering researchers. They grew quickly (especially in Maghreb, originating in popular strata and becoming a middle class proud of its technical nature). Alliances have thus developed between researchers in the public and the private sector (engineers in industry), or between academics and the productive sector[46].

2. Impediments.

But impediments are the other side of the coin. Career advantages linked to research achievements are poor, when compared to the financial benefits one may gain from *consulting activities and services* he could practise instead. This opportunity exists on a large scale in human and social sciences, in medical sciences, in agriculture and engineering; it may exist in specific branches of basic sciences (mathematics, chemistry, etc). In the Centres, research achievements are poorly assessed and taken in weak account for promotion. Moreover, the status of full time researchers is often less attractive than the academics' one.

Researchers and academics in the region are very busy attending multiple occupations other than properly research. This is not necessarily for financial reasons but much more (as we reported in our opening chapter) to gain *status*: for the social environment is not conducive to consider research as a most decent activity. This is why it is difficult to come across "total scientific communities", within which there is a full devotion to the activity.

[44] However, the Algerian government has just announced they would double the salaries of researchers and increase those of academics in the next months – a much awaited measure.
[45] This is also true in Lebanon, within the 2 main private universities which boast research as part of their label and demand research results from their lecturers: except for the public "Lebanese" University, they are the (almost) sole producers of publications in the country.
[46] Khelfaoui "Scientific Research in Algeria: Institutionalisation versus Professionnalisation", STS 9 :1, op cit.

Struggling with authorities and the academic establishment may also be very much time consuming[47]. Numerous monographs complain about the stiff hierarchy in the Centres, *bureaucracy* and authoritarian control through the whole machinery, and the *mandarin* style of academic patronage. Although they are not felt everywhere and they were proved sometimes undeserved charges, these features are at stakes as often as the question arises of the weak initiative among young researchers and poor ambition of their projects. Some of them even declare they left the country because of that[48].

3. Brain drain.

Some words should be said about **brain drain**. In spite of working conditions which are often better than in other parts of the world, Arab countries are well known for the number of scholars leaving abroad (or students never coming back after obtaining their degree). As usual reliable figures are difficult to find on this matter.

The main countries hit by an exodus are of course those where the profession is rather ill treated: Algeria and Egypt.

> According to the news paper *al-Mussawar*, quoting official sources, at least 15 000 students (Egyptian) settled abroad after getting their degree there during the 1990s (1500 per year). Most of them were specialized in engineering (50 %) and basic sciences (mathematics...). Moreover, Egyptian academics are well known for expatriating (more or less temporarily) to the Gulf countries (and other places, appealing to their skills).

By 2000 official statistics from NSF (USA) counted 13 000 Egyptian scientists and engineers established in USA, out of whom 5 000 were employed in the R&D sector. This could amount to 35 000 Egyptian highly skilled in S&T established in developing countries[49]. At this moment and for the Near East (in our definition: Lebanon + Jordan + Syria + Palestine + Kuwait for the main origins) the NSF figures were also spectacular[50]. (See Table below).

Table: Number of Scientists and engineers established in USA (born in the Near East). Year 2000

	Egypt	Lebanon	Jordan	Syria	Palestine	Kuwaït	Maghreb
Established in USA	12 500	11 500	4 000	5 000	2 600	2 400	ε
Employed in R&D	4 400	4 900	2 000	1 800	700	1 200	ε
Researchers in the country headcount*	75 000	6 000	6 500		Nd	2 400	40 000
Researchers in the country FTE*	15 000 **	600	750	400 **	Nd	500	8 000

Source NSF, cited in Barré & Meyer (2003). * = ESTIME ; ** STS

[47] One of the monographs reminds the famous case of Ali Musharrafa (a renowned quantum physicist in London at the beginning of the 20th century). In 1936 he agreed to come back home and became Dean of the Faculty of Sciences in Cairo University. He then spent 15 years 'trying to change the framework of Egyptian science and develop an Egyptian scientific community… His profusion of efforts was at the expense of his scientific career" for he almost stopped publishing. Recently, Ahmad Zwayl who won the Nobel Prize after a full career in USA acknowledged his debt to the Egyptian school (and tertiary education) but confirmed that he never found there the conditions for a total dedication to science. See S. Radi Country report, Egypt, *Sciences in Africa*, IRD, 2001 (French version on the net: www.ird.fr/fr/dss).

[48] See S. Radi and H. Khelfaoui, op. cit.

[49] The ratios come from official Egyptian sources. See S. Radi, Egypt (in Sciences in Africa) op. cit.

[50] See Barré & Meyer *Scientific Diasporas*, IRD, 2003, op. cit.

According to NSF, very few scientists from Maghreb were established in USA. But according to the Algerian trade unions the number of Algerian scientists established abroad had jumped from 2 400 in 1984 to 27 500 in 1994; and 90 % of scholarship holders never came back from abroad in 1995. To this should be added the well known exodus of "highly qualified persons" (among whom a number of leading researchers and academics) during the civil war of the 1990s. (Khelfaoui, 2004).[51]

Though the situation is less dramatic in Morocco and Tunisia, brain drain is also noteworthy. Scientists from Maghreb are heading for Europe (mainly France) and recently for Canada[52]. These two regions are hunting heads for they need (and will need more and more) scientists and engineers they do not train in sufficient numbers. Neighbouring Mediterranean countries (especially Maghreb with a lot of excellent trainees) are a first rate target.

4. Professionals need new incentives

The brain drain trend shows that there is a large S&T potential in Arab countries, and a lot of frustrations among them. Old formulas to mobilize capacities meet their limits.

Linking academic careers to research achievements has shortcomings. It encourages individual work, rather than more ambitious collective endeavours. And professors who get near or at the highest grade often withdraw from research: if no new recruits enter the system the "engine" jams. This is what is happening (as the enrolment of students is already at a high level, and there is a lesser need for recruiting large troops of teachers).

All in all, motives to persist in research do exist. But much depends on individual choices (and the capacity of some establishments to mobilize them). Though the theoretical potential is large, bibliometric studies show that there is only a small part of them who are really active. There is clearly ***a need for more incentives***. Some establishments (or governments) have tried out various solutions, which are worth reporting as good practices.

One of them consists in *financial rewards*. This may take the shape of a bonus (when participating in a large project, as in Egypt) or a promotion according to merit (as in Morocco, but the gain is thin compared to the possible earnings through consultancy during the same time). It may be a sharing of the benefits earned by the establishment on account of contracts (as in Algeria or in Lebanon).

In a more "de institutionalized" manner one could imagine that *market* provide for such incentives.

> In other parts of the world (Africa south of Sahara, parts of Latin America), *market* has been instrumental to develop a new model of professionalization: working freelance, for tailor-made results, often in an interdisciplinary way, through networks of clients and (international) customers, under the regulation of demand (and not of the peers or academic hierarchy). This sort of research generally sets up outside the boundaries of official establishments, at home or within private centres. There is no significant sign of such developments in Arab countries.

[51] H ; Khelfaoui « Scientific Research in Algeria: Institutionalisation versus Professionalisation, Science Technology & Society, 9:2, 2004 p. 75-101

[52] An unconventional bibliometric study in social sciences has just proved that 60 % of the 100 most productive social scientists from Algeria were now living and employed abroad (50 % of the 200 most productive, authoring more than 1/3 of the production in the last 25 years). The proportion of Moroccan authors living abroad is 15 % of the 100 most productive (Rossi & Waast, ESTIME, HSS bibliometrics report).

except for social sciences in Machreq. Demand is rather small, except for little sophisticated services in specific areas (agriculture is one of them). Research consultancy is limited and there are very few private research centres.

Personal incentives are useful. They are at least a symbolic recognition of the work done while others bustle about different businesses. But many scientists who have a vocation for research are just longing for a normal "laboratory life". The most convincing encouragements are for them linked to *the structuring of research*. This was very obvious in Tunisia, when laboratories were established and continuously supported on condition of their positive assessment. Active researchers joined them, stick to their activity and declare they are satisfied. The same is true in Algeria (though the process is less advanced).

Clearly, there is room for progress in the mobilisation of a larger potential. Without giving up the link of careers to research merit (if better assessed and rewarded) this calls for some new personal incentives and a large share of institution building.

E. Output

In spite of seemingly adverse conditions (underexploited potential, hesitations about the function of research and the support it deserves) *the output is growing*: at least the number of articles published in high-quality international journals. There has been a lot of discussions about such a measure. Nevertheless, it offers interesting indicators of the (academic) activity, its strong points and its evolution. Some salient points are discussed below:

- the number, quality and evolution of the production, according to different sub zones and comparing the whole zone to the world research
- the very typical specialization of Arab countries
- collaborations (including international cooperation), networks and the role of a limited number of authors

We'll then elaborate about two specific questions:

- the production of the human and social sciences; and
- the links with society, through contributions to engineering, economic innovation and social problems solving.

1. Production is modest but steadily and (sometimes) greatly growing.

The whole zone progressed significantly during the twenty last years (See Descriptors). While almost invisible before the 90s[53], it now contributes to *1% of the world production*. This is a modest but meaningful change. The growth was quicker than in the rest of the world – especially the developing world.

The movement was not the same in different sub zones. Egypt progressed slowly during the 80s and even stagnated during the 90s. Since 2000 it has regained momentum and this is linked to a new leap forward of the number of students (and staff in the Universities). Machreq went at a quicker path; but this is especially true in Jordan (which almost doubled its

[53] Except for Egypt.

participation in the world science during the last decade) and in Lebanon (after the civil war and thanks to numerous foreign cooperation). However the most remarkable feature is *the spectacular growth in Maghreb production*. Within the last fifteen years Morocco more than doubled its participation in articles published by the best international journals (nearly 1 000 participations each year). Algeria did the same in spite of a six years civil war (during which the progression slackened pace but did not collapse); there is now a staggering bounce, following the new potent support of the state to research and the restoration of calm. Tunisia shows the most constant and powerful growth. It almost tripled the number of its publications in the last decade, and the growth is accelerating since the new structuring of research and its nurturing by the state (1998 sq). On the opposite side, the Gulf countries are stagnating (as well as Saudi Arabia) except for the countries (Emirates and Qatar) which imported foreign campuses: thanks to these contributors their scores increased tremendously – but they remain modest (200 to 400 participations per year)[54].

All in all Arab countries have doubled their number of participations in the world science (and increased their world share). They owe it principally to a fit of enthusiasm in Maghreb during the last two decades.

2. The second main feature is the distinctive specialization of this production.

Though they have capabilities in life sciences most countries have a predilection for basic (math, physics, chemistry) and *engineering sciences*. This is particularly true in Egypt (which excels in all sorts of engineering) and Maghreb (Algeria being an extreme case, as shown by its diagram of specialisation in the Descriptor section). Machreq countries are more balanced. They owe it less to a policy will than to the whims of fate regarding the strong points in Research Universities (as medicine is, according to a long tradition, at AUB or St Joseph in Lebanon). A remarkable point is that these specialities are strengthening over years.

3. The impact of research is somewhat deceptive.

It measures around 0,2-0,3 against 0,4-0,6 in Latin America and 0,8 to 1 in developed countries[55]. This can be attributed to an ordinary misappreciation of science in the developing world; and to language factors (lesser command of the English language; more publication in non English speaking European journals). But this has probably also to do with cooperation, directed towards subcontracting piecemeal projects instead of a full participation in ambitious international programmes; and with the atomization of the production, relying on a few individuals, very small teams and short networks. As indicated earlier there is often the lack of a "critical mass" and even the strong points in a specific establishment depend on a very small number of active researchers. There is need for a more appropriate *structuring of research* (a responsibility for the government), not to mention the emergence of scientific communities.

4. Human and social sciences are active

[54] Kuwait experienced a great hollow (more than half of its contributing capacity) during the Gulf war and after expulsing a number of highly qualified persons of "hostile nationality". Only since the 2000s years does it come back (almost) to its 1990 level.

[55] The relative impact index is the ratio (in the SCI database) of the world share of citations received over 2 years to the world share of publications of the year indicated. The neutral value of the index is 1. A value less than 1 indicates that the country's publications are less visible than the world average.

Generally the production of **human and social sciences** is not well known. There is no consensus on acceptable databases recording their main works (books as well as articles or chapters in collective publications). Fortunately, and for Maghreb only, we could use a bibliometric study realized from the catalogue of a very comprehensive library[56]. Some results are interesting.

- The productivity of researchers is neighbouring that of their colleagues in "hard" sciences (an average 2 items each 7 years). About one third of the work consists in books, 1/3 in articles, and the rest in chapters of books.
- It is very concentrated: The 15 % most productive authors sign 60 % of the pieces of work, and a small 1% makes for 15 % of the corpus.
- There is very little co-authorship. The circulation and the borrowing of ideas, debate, intercommunication and participation in shared ventures cannot be approached in this way. They should be traced otherwise (kernels of authors in a publishing house, in the scientific board of Journals or Conferences, etc).
- 2/3 of the corpus is written in *Arabic language*. Many authors write alternatively in Arabic and in a European language (most of them in French, for this is Maghreb).
- The *main disciplines* are literature (and fine arts), law and history. Sociology, economics and political sciences are also important. Other disciplines are much less represented[57]. Psychology is the great missing subject.
- The *main themes* deal with the freeing of the country and resistance attitudes toward colonisation, the cultural features of ancient Arabic civilisation, and questions of identity. Economics treats now of management more than of development strategies. Societal questions like "women", "democracy and associations" and violence in "political crises" are gaining momentum while pragmatic topics have carved out their place (urban problems, agriculture, education and all sorts of juridical issues).
- There are some variations among the countries but a great similarity of concerns and moves. The main difference is rather between disciplines which are nomothetic (they seek social "laws": economics, sociology, linguistics…) and others which are more descriptive or topical (philosophy, history, arts & literature…). They have distinctive themes and a specific relation to language[58].

In Machreq and the Gulf the situation may be different. Arts and Humanities have the largest space. They enjoy public interest and they have ample sponsorship. Social sciences are less popular; but they are pragmatic, their best scholars are often called as experts or consultants by authorities, a number of teams practise action research and there is an international market for their studies and work (especially in Machreq).

5. Finally, what are the links of research with society?

It is clear that arts and humanities have an audience (through the media and many students[59]) and a large sponsorship. Social sciences have their own (they often teach in different Faculties

[56] ESTIME (2007): Bibliometric study (Maghreb) in human & social sciences.
[57] Though influent like islamology and *philosophy* or proportionally well developed – as linguistics.
[58] Nomothetic disciplines need to enter debate all over the world: they write in European languages. Topical disciplines speak rather local languages (here: Arabic).
[59] In Kuwait, 45 % of the university graduates receive their degrees in the humanities, 18 % in public administration, 12 % in Islamic law. Graduates in medicine and sciences represent just 26 %: Furthermore 67 % of all graduates are women (many male students study abroad).

and they are more committed to private consultancies)[60]. What about natural and exact sciences? They are less readily understandable by a great public and their "would-be" sponsors (the economic sector) often claim they do not fit their needs.

It's true that very few patents come out of Universities. But links with industry go through other ways: continuing education, technical services and consultancies. An assessment of the S&T system in Morocco has shown recently that there are many more collaborations than expectations were[61]. Most of them remain informal. They result from scattered and individual initiatives. They involve specifically Engineering "Schools" (more visible than the University labs, which are often under-equipped and badly marketed by their own establishments). And they concern a fringe of innovative firms: their characteristics have just been well documented by several "innovation" or "S&T potential" studies in Jordan, Tunisia and Morocco[62].

Conventional views of academics and businessmen remain those of mutual incomprehension. But beyond official words practical experience may be different. Opinions of "executives" were interesting to pick out (See Descriptors: Arab countries report from the World Economic Forum). The result is a very good *world ranking* of several countries for the availability of scientists and engineers[63], local research & training services, the quality of scientific institutions and University-industry collaboration. Tunisia is excellent for all these issues (and several other related indicators). Emirates and often Qatar are very good. Morocco and Jordan have good or very good rankings. Algeria, Egypt and Syria have weak points (mostly for services and collaborations).

F. Conclusion

We may sum up this report saying the Arab countries have by now an important S&T potential, little tapped for research. Consequently brain drain takes a heavy toll: a few years ago, there were as many Egyptian scientists employed in R&D through the world as there were (FTE) in their own country; and twice to four times more regarding Machreq countries[64].

There would probably be much to gain if the *function of research* were recognised and considered as a lever for development. The governance of science is a rather a new concern in the region. Whether it takes the forms of centralisation (Maghreb, Egypt) or that of more discreet Councils (Machreq) they do not prevent the research apparatus to be fragmented. Much depends on grassroots initiatives, the culture of establishments and the good will of individual researchers. The Gulf countries are original, as they don't seem eager to build a national science base (research is rather a vestment for universities and an ornament for

[60] At the same time all these sciences broaching values and policies can be suspected of plots, in spite of their best stars being publicly known and called as experts. Their media coverage blurs the distinction between high quality thinkers and quack amateurs. This is the reverse side of the coin and calls for a serious arbitration which scientific communities are not yet armed to fulfil.

[61] See Kleiche et al. *Le maroc scientifique*, op. cit.

[62] See ESTIME project. Of course, a number of patrimonial firms operating on protected markets are not interested in technological innovation. And innovation goes often through incremental in-house improvements that don't turn to R&D external services. But readiness to technological learning creates opportunities for informal collaborations with researchers (often through private networking).

[63] Excellent for the whole Maghreb, very good in Egypt and Syria.

[64] There are no reliable figures for Maghreb countries, but brain drain costs them dear: especially in Algeria, where the profession is ill treated. According to NSF (2000), Kuwait was much hit but not other countries from the Gulf.

sponsors) but to attract excellent foreign campuses and successful multinational firms, letting them organize their relations.

Scientific and technological production (which grew much during the last 2 decades) finally relies on a small number of performers (a few research universities plus – in Egypt and Maghreb – some Centres and Polytechnics); and on a small number of researchers in each of them (working often on an individual basis, or within small teams and short networks). Old mainsprings of this activity (like professional values, and linking the career of academics to some research achievements) are running out; and there is a need for institution building and new incentives. Good practices have been described. The most efficient one seems to be the structuring of research through strictly assessed laboratories and research units (as in Tunisia[65]).

Research (which by now is a subordinate function in different types of establishments, or a vestment and a hobby for a few volunteers) could then be taken seriously (for itself, with its own goals and system). Its ambitions could become greater and its relations with society clearer and more efficient.

There is a responsibility of foreign cooperation (already active) to contribute to this upgrading: at least by supporting for long specific laboratories and helping them to enter into intense networking or/and large programmes with serious technological stakes.

We may end this report by stressing the following point:

There is a need for accurate data and follow up studies in the region.

> Some countries already realized inventories of their scientific potential (and even of their R&D potential: Jordan). Some organized the assessment of their S&T system (Morocco). These concerns are clearly gaining ground, even where we had difficulties to find relevant information about the current status of research (Egypt, Gulf countries).

Beyond that is the need for updating such data. Tunisia has just launched its "Observatory of S&T", and Lebanon prepares for that. Others are considering it (Jordan, Morocco). As all the countries are different (science goals and policy, governance and supervision, performers) each of them needs to put a specific service in charge of gathering reliable and consistent data.

The next (parallel) step would be to promote a regional Observatory (and at first a *network* of the ongoing ones) that could help in standardizing and validating the data (as RYCYT does for Latin America), analyzing them and launching specific studies (e.g. a benchmarking of good practices). It could also support capacity building. It seems that such a proposal is timely: it could meet approval and gain sponsorship in the region.

[65] This implies that such units receive long standing support, and gain access to up to date equipment and documentation.