Linking Knowledge Economy and Environmental Performances: Evidence for Arab countries.

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Abstract: Arab countries face two major challenges resulting from increasing competition from the rest of the world and persistent reliance on mineral resources for their growth. At the same time, sustainable development and the protection of the environment are becoming increasingly major concerns for world development since the Rio Summit in 1992 and more recently et the COP21 in Paris. It is increasingly recognized that sustainability requires more and more knowledge assets and capabilities. Knowledgecan make substantial and essential, contributions to sustainability across a wide range of placesand problems. In this respect, and from a sustainability point of view, knowledge economy opens up new and more accessible opportunities through the 'substitution' of physical resources by immaterial resources. Looking at a sample of Arab countries, our paper will argue that sustainability of growth rests fundamentally on the capability of properly harnessing knowledge.

Keywords: knowledge, knowledge-based economy, sustainable development, Arab world, sustainable knowledge

الملخص

تواجه الدول العربية من أجل النمو تحديين أساسيين ناتجين عن زيادة المنافسة بين دول العالم والاعتماد المستمر على الموارد التعدينية،في نفس الوقت، التنمية المستدامة وحماية البيئة أصبحت تمثل بصفة متزايدة أهم الاهتمامات لضمان التنمية العالمية منذ قمة ريو(RIO) عام 1992 ومؤخرا خلال قمةCOP21 في باريس. حيث أصبح هناك إدراك متزايد بأن الاستدامة تتطلب المزيد من القدرات وأصول المعرفة. فالمعرفة بإمكانها المساهمة بصفة أساسية وكبيرة لضمان الاستدامة في عدة أماكن ولعدة مشاكل.

في هذا الصدد، ومن خلال وجهة النظر المقدمة حول الاستدامة، يفتح اقتصاد المعرفة فرص جديدة وسهلة المنال من خلال "استبدال" الموارد المادية بموارد اللامادية. بالنظر إلى عينة من الدول العربية، ورقتنا البحثية ستحاول إثبات أن القدرة على التسخير الصحيح للمعرفة هو الضمان الأساسي لاستدامة النمو.
الكلمات المفتاحية:المعرفة، الاقتصاد المبني على المعرفة، التنمية المستدامة، الدول العربية، المعرفة المستدامة.

Introduction

Sustainable development is becoming increasingly a major concern for world development since the Rio Summit in 1992 and one of the major challenges on the international agenda in the face of worsening indicators of most resource-use and worsening environmental impact. The 1987 Brundtland Report, of the World Commission on Environment and Development, (WCED 1987) defined sustainable development as "the development that meets the needs of the present without compromising the ability of future generations to meet their own needs". The new regulatory principle, “pollution prevention pays”, aims at promoting competitive and environmentally sustainable industrial production. While many of the work and resolutions are centred on costs and pricing both in terms of understanding and as a policy instruments, it is only in the last few years that science and technological capabilities issues are recognised as deserving to be given top priorities. It is gradually recognized that sustainability relies more and more on innovation capabilities and on harnessing the necessary knowledge. In LDCs, the situation is more challenging: while GDP growth of 6% to 8% per year is needed in the next three or four decades to meet all their needs, they have to comply with sustainability requirements while developing the necessary knowledge assets and capabilities, they often lack. The transition to a global, networked knowledge economy will be one of the most important social and economic changes of the next decades. Knowledge is known, to be sometimes to be difficult to access and its price is distorted by world market, under intellectual property rights and other restrictive practices which do not benefit LDCs. This is the case Arab countries where the level of innovation performances remains weak and where major investments made in education, training and research have yielded only limited results. This situation

raises two fundamental questions. The first one relates to the opportunity of insuring sustainability of growth while competitive pressures drive these countries to maximum use of natural resources, over-crowding of cities, and the acquisition of packaged, ready to use technology, produced elsewhere. The second one relates to the relatively weak knowledge base and the difficult integration of knowledge economy approach in most economic policy agendas (Djeflat 2006b). We will argue, in this chapter, that sustainability of growth rests fundamentally on the ability to properly harness knowledge. In other words, "sustainable knowledge" remains paramount to sustainable development. This raises important theoretical and conceptual issues on the linkages between sustainability of development and knowledge. From an empirical point of view, we will try to analyse the difficulties met in the process of putting knowledge to work for sustainability while stressing some of the new opportunities. In this endeavour, we will look, in a first section, at the relationship between knowledge systems, knowledge economy and sustainability from a conceptual and theoretical point of view. The second section will raise the issue in relation to Arab countries with the objective of highlighting the effects of low knowledge base on sustainability. A third section will examine from an empirical point of view this relationship and its measurement, using data from Arab countries.

1. Sustainable Knowledge for Sustainable Development: Concepts and Issues

There is an increasing belief that science, technology and knowledge play an important role in sustainable development (Dayan 2005). Consequently knowledge systems and knowledge economy seem to open up new and varied avenues to be explored in the direction of

sustainability. How can knowledge enhance sustainable development? This is the main issue we will address in this section.

1.1. Knowledge systems and sustainable development.

In an organised economy, according to the loops of re-using resources and the quality of information, development and efficiency are not dependent anymore on salaries and large scale of production. The critical resources become practical knowledge, local entrepreneurial dynamism, and trust, cooperation over the fence among organisations, human intelligence and know-how. This leads to an "economy of human intelligence" (Dayan 2005). Knowledgecan make substantial and essential,contributions to sustainability across a wide range of placesand problems (International Council for Science 2002). Unless that contribution can be dramaticallyincreased, however, it seems unlikely that the transition tosustainability will be either fast or far enough to preventsignificant degradation of human life and the earth system (National Research Council, 1999). To achieve that level of contribution, several conditions need to be fulfilled. They relate to the specific nature of knowledge, to successful combination of material and knowledge assets, and to the type of knowledge system.

Firstly, regarding the specific nature of knowledge, it obeys public goods rational and evolutionary principles on one hand and market rules in a neo classical framework, on the other as seen earlier (Djeflat 2006b). Integrating knowledge and sustainability requires often a mix of the two in a pragmatic way. It is clear from table 1 that sustainability is easily reached when knowledge is public, non competitive, codified and source of high externalities. It can thus be more easily circulated and shared amongst various actors. Its potential for sustainability is reduced if it is privately owned, subject

to market rules and fierce competition, highly protected, tacit, and specialised and under the constant threat of obsolescence. Secondly, as a result of ever increasing proportion of knowledge in the production of goods and services, more and more emphasis is put on knowledge assets as source of wealth creation. However, these kinds of assets may not be easily grasped when it comes to sustainability. Several studies reveal that sustainability can be more easily achieved when material assets are efficiently combined with knowledge assets. Industrial ecology, for example has already explored avenues for combining efficiently material and knowledge assets. Knowledge management is one of the key elements in this process (Dayan 2005).

Thirdly, it became more and more evident that sustainability depends on developingintegrated knowledge systems, a lesson already learned in theagriculture, defence, and health sectors (Cash et al. 2003). Knowledge system approach appears to give knowledge more effectiveness in harnessing S&T with the goals of sustainable development. A Knowledge system is viewed as consisting of a network of linked actors, stakeholders, organizations, and objects that perform a number of knowledge-related functions (including research, innovation, development, demonstration, deployment, and adoption) that link knowledge and know-how with action. Included are also incentives, financial resources, institutions, and human capital that give such a system capacity to do its work. Bearing in mind that usable knowledge is ultimately "contextualized," i.e., adapted to specific circumstances or places, several issues can be raised: they relate to the generalization of the effective knowledge systems to various places, sectors and problems including governing knowledge systems (Matson 2007), to the kind of knowledge which needs to be mobilised (formal, clinical or tacit knowledge), to the mix of knowledge to be used and to pricing. Recent contributions have

developed a critical review of controversial economic theories of pricing natural capital and knowledge capital that affect prices (Nguyen 2006). Finally they relate to the balance between intangible capital and material resources. The importance of the intangible resources in sustainability is increasing. While production and growth are material-centred, sustainability appears to rest more on intangible assets used to exploit material resources. A development strategy that focuses only on production capital and neglects intellectual capital is therefore not sustainable. However,society lacks a critical understanding of what kindof programs, institutional arrangements, and, more generally,knowledge systems can most effectively help in harnessing S&T forsustainability (Cash et al. 2003). Knowledge economy approach appears to give a more accessible and easily understandable relationship between sustainability and integrated approach to knowledge.

1.1 Knowledge Economy and Sustainability

Knowledge system paradigm is usually put in the framework of knowledge economy. It could be defined as "the economy in which knowledge is the key resource and in which the generation and exploitation of knowledge have come to play a predominant part in the creation of wealth" (Department of Trade and Industry 1998). The knowledge economy framework (Dahlman 2003) uses a systemic approach of four pillars (innovation, education, ICTs and institutional framework) which shows how knowledge is created, circulated, valorised and governed for the purpose of economic development and growth (Aubert and Reiffers 2003). In an earlier work (Djeflat 2006a) we addressed several issues relating to the relationships between knowledge economy and innovation systems. This section will look at the new opportunities for sustainability that knowledge economy offers. Theknowledge economy paradigm suggests that physical

resources can be almost infinitely stretched through the 'substitution' of physical resources by information, knowledge and immaterial resources, giving thus new prospects for sustainability. Examining closely each one of the components, gives deeper insight into this relationship.

Firstly, ICTs have brought tremendous potential for sustainability and environmental protection and several contributions have listed the countless possibilities which they bring: (learning, database collection and storage, diffusion of vital information, data generating systems, monitoring and control of environments etc.). Recent studies illustrate ICT's potential for sustainability (Mansell and When 2005). In Indonesia, for example, a programme initiated by the Forestry Ministry to aid in sustainable forestry management involved identifying and coding of trees, optimizing forest maintenance and training in the use of laptop computers using specialised software (Talero and Gaudette 1995). Other techniques include computer-aided, scientifically applied, modelling techniques, networking and information exchange. Several international organisations and institutions have built all their environment and sustainable development programmes on ICTs. For example, UNDP built a Sustainable Development Networking Project. This is a specialised on-line system for scientific, technical, bibliographic, and institutional sources. The network currently consists of 173 national, government-designated focal points that are collaborating with the UNDP. Other important issues include the inter-generational transfer of masses of information and know-how in the era of internet (Ermine 2008, Vachon 2008).Secondly, innovation is a key element in sustainability**.** In the drive to highlight the fundamentals of sustainability, many scholars have concentrated on cost and benefit, the two key elements in decision-making for environmental protection (Tilton 1992,

Warhurst 1998). This approach in terms of cost/benefits however fails to integrate the technology factor. From an empirical point of view, studies conducted in the mining sector have shown that environmental degradation is greatest in operations working with obsolete technology. Firms that pollute the most are mismanaging the environment precisely because of their inability to innovate and the most efficient firms are generally better environmentally managed, because they are innovators (Warhurst 1998). Examples from the literature show that innovation can reduce pollution, and that firms that adopt this strategy build competitive advantages as well as environmental benefits. In the mining sector, environmental performance of an enterprise is more closely related to its innovative capacity than to the regulatory regime under which it operates (Lagos 1992, Acero 1993). Companies adapt to environmental regulatory pressures by innovating, improving, and commercializing their environmental technology and environmental-management practices, at home and abroad. New and more stringent noise pollution regulations in the seventies saw the emergence of a host of new products and services for noise control in Great Britain and some Scandinavian countries, including from the polluters themselves (Djeflat 1975). On more global terms, technical innovation, for instance in terms of developing substitutes to naturally scarce raw products, may help to overcome the fact that natural capital cannot always be reproduced. (Johnson and Lundvall 2000). However, pollution control and environment protection are only one of the objectives of sustainable development. Sustainability is also about reducing poverty, education, health and welfare, and rural development. Finally, innovation requires that innovative capabilities are transferred to future generations on top of the fact that some results of fundamental research may be stored to meet future needs.

The various spheres involved in environment protection include : industry, research, government, donors, social acceptance and information sphere. Thirdly, education and training need to be singled out when raising the issue of sustainable development not only because of their importance in the production of appropriate knowledge, but also in its diffusion and renewal. As stated in the world summit for sustainable development, young adults tend to emerge from the educational system without a deep sense of ecological matters and without knowing what to do with the knowledge they have. They are unequipped to make decisions that are environmentally enlightened when they take their place in the work force (International Environment Forum 2002). The new education paradigm should therefore foster different values and attitudes such as cooperation instead of competition. Such an educational approach would be participatory, interactive, integrative, value-driven, and knowledge-based i.e. that it encourages creativity, innovative attitude and the constant drive to renew its stock of knowledge. Knowledge is under the permanent threat of being obsolete and requires learning permanently through the academia and interactive lifelong learning.Finally, one of the key questions is how institutions can play an adequate role and give the necessary atmosphere to mobilise knowledge for sustainable growth and development. This issue raises another question relating to the private sector involvement, both as user and as a source of relevant knowledge for sustainability (Hardi 2000). It involves also all the other issues addressed usually by public economics of free-riding, prisoner's dilemma, aligning incentives, and thedistribution of authority applied to knowledge (Olson 1971). Policy aims generally at integrating sustainable development as a guiding principle in all government actions in order to ensure that economic and social

development keep within ecological limits, particularly in the area of S&T policy, where there is a lack of incentives to set strong priorities for promoting sustainable development.

1. **Knowledge And Sustainability in an Arab Context**

The issue of knowledge and sustainability in Arab countries, in particular, raises several questions, as a result of a weak knowledge base, incomplete innovation system and often weak sensitivity to sustainable development gains. As remarked elsewhere, these issues may seem as luxury in a continent were poverty, hunger, illnesses, disease and conflicts prevail (Johnson and Lundvall 2000). However, one cannot help relate the issues of Arab development to that of sustainability based on knowledge, where current endogenous capabilities are weakened by limited access to advanced technology and its difficult transfer. Yet when examining the linkages between knowledge and sustainability, it becomes clear that new opportunities exist for Arab development. We will examine, in this section, what these difficulties are and what new opportunities exist.

Knowledge systems and sustainability raise specific issues from a developing country perspective, in our view. The relatively weak knowledge base and the difficult integration of knowledge economy in most economic policy agendas are more than obvious. In an earlier work we have highlighted some of the impediments (Djeflat 2006 b). While the impact on the local industry can be quite substantial in terms of employment creation, outsourcing to local industry with the aim of upgrading their facilities and know-how, and perhaps in some cases, triggering a real innovation dynamics, examples and success stories to substantiate that, are still relatively limited and particularly when it comes to Arab countries, with the exception of South Africa. It is recognized in recent contributions, that building more effective

knowledgesystems for sustainability takes time and patience (Cash et al. 2003). Strategiesto promote such systems require a sufficiently long-term perspectivethat takes into account the generally slow impact of ideas onpractices, the need to learn from field experience, and thetime scale involved in enhancing human and institutional capitalnecessary for doing all these things. A decade or more thusseems the minimal period over which efforts are deployed to harness S&Tfor sustainability (International Council for Science 2002, Lubchenco 1998, Unesco 2000). In many Arab countries, pressure for development, coupled often with the need to face global competition, leave very little scope and room for manoeuvre for decision-makers to start off this long-maturing process. ICTs, while making remarkable progress in recent years, are very much in the realm of digital divide and again more demand and less supply oriented. Education and training as a means of knowledge diffusion and competence building face major obstacles. As seen earlier, knowledge which is vital to sustainability sees its price distorted in the face of high intellectual property barriers. Institutions are mismanaged and governance appears to be a common concern for the majority. While stressing all these difficulties in harnessing knowledge systems, there are several opportunities which the adoption of the knowledge economy approach opens up for Arab countries in terms of sustainable development. ICTs give new opportunities for taping into global knowledge for Arab countries and improving their relatively weak local knowledge base. They also give them the opportunity to extend their knowledge system to include their Diasporas as shown by success stories in India, China and South Korea. They finally give the opportunity for local firms and research institutions to integrate knowledge networks and update their often obsolete tools and methodologies. New opportunities offered by e-learning can help

reinforce the often weak education and training system. Paradoxically, while the much publicized digital divide is a real issue for Arab countries and indeed raises the threat of these countries being left behind, the "knowledge divide" is rarely put forward as another possible risk enhancing what we could call the "sustainability divide" which is gradually taking place. Improving the knowledge base of Arab countries will, therefore, lead to higher potential for sustainability as we have hypothesized and we will try to substantiate in the next section.

1. Measuring the link between knowledge and sustainability.

From an empirical point of view, knowledge systems appear to be closely related to sustainability. Two indicators have been selected to show this relationship: the knowledge index and the sustainability index.

1.1 The Knowledge Index

As explained earlier, the knowledge economy builds on indicators and variables: the two main parameters are the knowledge economy index (KEI) and the knowledge index (KI). The knowledge index, which appears more appropriate and for which data are available for a sufficient number of countries, measures the ability to generate, adopt and diffuse knowledge. It constitutes an indication of overall potential of knowledge development in a given country and is defined by the World Bank Institute as "the average of the normalized performance scores of a country or region on the key variables in three indicators: education and human resources, innovation system and information and communication technologies" (Dahlman 2003). The three indicators include several variables related to knowledge generation and knowledge diffusion. These are Education and training,

innovation system, ICT and institutional framework (World Bank Institute 2001).

The normalization procedure brings all the indicators to the same standard of measurement through the process known as normalization through the next formula:N(u) = 10*(1-Nh/Nc)where N(u) represents the normalized score of an index, Nh represents the number of countries with high rank and Nc the total number of countries in the sample with available data.

3.2. The Environmental Performance Index.

The EPI addresses the need for a gauge of policy performance in reducing environmental stresses on human health and promoting ecosystem vitality and sound natural resources management (Yale Centre for Environmental Law & Policy and Centre for International Earth Science Information Network 2005). The EPI builds on two broad environmental protection objectives: (1) reducing environmental stresses on human health, and (2) promoting ecosystem vitality and sound natural resource management. Environmental health and ecosystem vitality are gauged using 25 indicators tracked in six policy categories: environmental health, air pollution (effects on ecosystems), water (effects on ecosystems), productive natural resources, biodiversity and habitat, and climate change. The EPI utilizes a proximity-to-target methodology focused on a core set of environmental outcomes linked to policy goals. The 2008 EPI includes 149 countries based on data availability (Yale Centre for Environmental Law & Policy & Policy Centre for International Earth Science Information Network, 2008). The empirical analysis was conducted on the seventeen Arab countries for which complete sets of data for EPI and KI are available. The non availability of published data made it difficult to include all Arab

countries. Both least square and correlation coefficient methods are used to have complementary and more robust results.

3.3. Environmental Performance Index and Knowledge Index

The environmental performance index scores of 2008 make it appropriate to cross with the 2008 KI index. Arab countries which score relatively low in Knowledge Index are also ranked in low positions in the EPI. These latter seem to have higher EPI scores: Algeria's score for example is nearly equal to that of the Netherlands even though its KI is fifty per cent less. This is partly due to the fact that these countries have made a significant progress in environment protection in recent years, particularly from the institutional point of view, but slower progress in knowledge, namely as a result of poor innovative activities (Djeflat 2006).

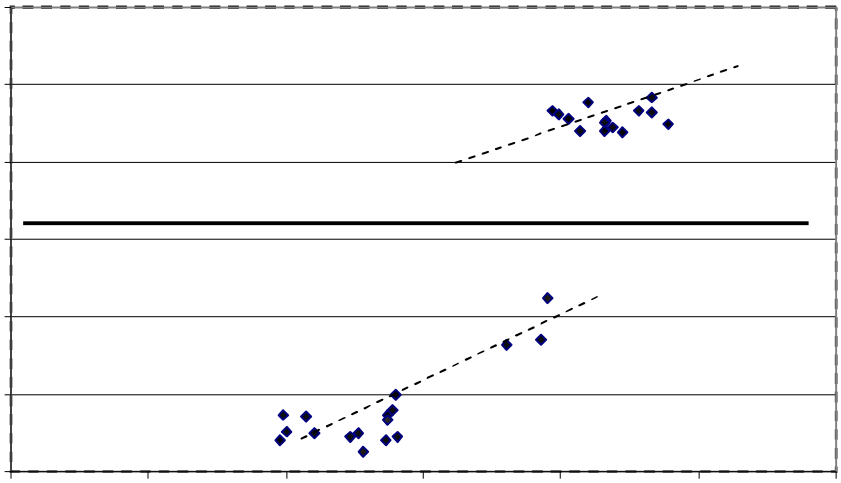
Table 1. Environmental Performance index and knowledge index in Arab Countries

	EPI 2008	KI 2008
Tunisia	71.8	4.50
Oman	70.3	3.02
Jordan	76.5	5.23
Algeria	77.0	3.42
United Arab Em.	64.0	5.69
Morroco	72.1	3.26
Egypt	76.3	4.07
Syria	68.2	3.07
Mauritania	44.2	1.01
Lebanon	70.3	5.55
Saudi Arabia	72.8	4.93
Yemen	49.7	1.26
Kuwait	64.5	5.45

Source: World Bank Institute 2008 &"2008 Environmental Performance Index" Report

This is clearly shown by graph 1. Advanced countries tend to concentrate in the top right of the first half of the graph, while Arab countries are in the bottom left part with a clear cut off line in the middle. The least square line indicates a relatively strong relationship which is reflected through the relatively high coefficient correlation R2 = 0.9296 and R2= 0.8402 for Arab Countries taken separately. This is an indication that in the case of Arab countries, knowledge counts a great deal for sustainability. Further research is needed to shed more light on these issues.

Graph n°1: Spread of EPI and KI scores



1. Discussion

Knowledge systems are thus closely correlated with sustainability both in developed and in developing countries. And indeed, the weak position of Arab countries in the sustainability grid is partly the result of their difficult access to knowledge with all its components. One of the key elements of this difficulty is the issue of technology transfer;

the second one is the innovation issue which is closely related. Firstly, technology transfer has always been an issue of concern for Arab countries who have remained for decades, permanently dependent on their technology suppliers (Djeflat 1988). Under competitive pressure and market rules, technology suppliers have no incentive to transfer technology to recipients. However, in the area of environmental protection, there are grounds, according to several scholars (Warhurst 1998), for a "new type of technology transfer" to take place in environmental management. It includes the knowledge, expertise, and experience required to manage technical change, the development of human resources to improve overall production and energy efficiency and environmental management of plants and facilities. It emphasizes training and skills acquisition, the novelty being the emphasis put on training and skill acquisition in environmental R&D. However, evidence from the field tends to suggest that this process has some limitations. Examples from the mining sector show that international firms transfer significant amounts of managerial and engineering expertise through joint ventures and other collaborative arrangements but limited to the specific project. Yet, these contributions can be considerably increased without adversely affecting the supplier's strategic control of its proprietary technology (Bell 1990, Warhurst 1991a, b, Auty and Warhurst 1993). Donors and international organisation can sometimes help suppliers to transfer their technology: they usually cover the costs of such operations. One of the programmes of Agenda 21, for example, encourages self-regulation, environmental R&D, worldwide corporate standards, and partnership schemes to improve access to clean technology worldwide. However, for this transfer to be effective, a substantial increase in the technological capabilities of recipient countries is required (Barnett 1993). This new concept mostly examined in a

Latino American context does not seem however to be easily generalized to Arab countries where the mining sector is relatively important as a foreign currency earner and where it is almost fully dominated by technology suppliers. Secondly, innovation is to be put against "most pressing needs" issue. Pressing needs include of course hunger, poverty, protecting the earth life support system and biodiversity. Two questions can be raised: the first one is what drives Arab countries to innovate for sustainability, if ever? The second questions is what S&T capabilities could they mobilise? There are several motives for Arab countries to innovate for sustainability: firstly, because upstream, some of them suffer from resources limitation which requires using them in a very parsimonious way not to have to undergo heavy environmental costs they could not bear and to guarantee to future generation access to a certain amount of these resources. Secondly, they need to innovate because of the many problems they are suffering from and which conventional techniques and approaches have proved difficult to resolve. Innovation has to be in all fields and not simply in the technical field: in the social, the political, and the organisational fields. While all this drive to innovate exists, there are several impediments and we have highlighted some of these looking, specifically at Middle East and North Arab (MENA) countries in previous contributions (Djeflat 2000). The most important impediments include the cost to the environment which does not seem to be strong enough to have a significant impact and which is usually externalised at firm level and does not constitute a strong motive to undertake innovative activities in this sense. This situation is found in the mining sector in Latin America (Warhurst 1998) and can easily be found in the oil sector (Algeria, Libya) and in the phosphate industry (Morocco) (El Khabli 2001). The second one is the force of regulations which normally should be a driving motive

and which, in an Arab context faces several obstacles due to governance problems and widespread corruption in the judicial system in particular. The third motive relates to social pressure which is relatively weak, the communities and villages most affected by pollution, environmental hazards and non sustainable behaviour have very little voice at the political level to express concern and put pressure on polluters to undertake technical or organisational innovation. Examples from the oil sector in Algeria show that major oil companies started changing their attitude and being more concerned with pollution control and environment protection only when, their key technical personnel started exercising pressure when they felt personally at risk. Pressure could not come from villages and populations living in the affected areas as a result of flared gas and severe air pollution. The fourth one is pressure from international organisations. This factor seems, in the current situation the most plausible factor which can have a significant impact on Government and firms to change their technologies and organisation to more responsible behaviour. However, the limited financial means of already debt ridden Arab states make it difficult to divert precious resources to innovation, while other urgent needs are not satisfied. Moreover, it may have a counter-productive effect, and lead to a drawback in sustainability as a result of less investment for poverty reduction, health protection and education promotion. International public funding could play an important role in this respect. Credit conditionality could help enterprises change their technological and environmental behaviour (Warhurst 1998). The fifth one is related to the support coming from donor organisations, which have had some significant impact in recent years. This was the case in the agricultural sector where some progress has been made using local competences in R&D to find local solutions to problems such as crop

disease, water treatment or water-saving irrigation techniques. However, these success stories are far too limited, not sufficiently publicised and far too concentrated in agriculture and less in the industrial sector.

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