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Technology and Development: Implications for the Middle East

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I. Introduction

This essay focuses on the role of "technology" for "development" in the context of unrelenting globalization and the complexity of its attendant impacts, with special attention devoted to the Middle East. I argue that (a) patterns of globalization shape new forms of deprivations worldwide, which, in turn, force us to consider the *deprivation-development* connections, as well as ways to "level the playing field"; (b) advances in technology, triggered by innovations in industrial states, create new "spaces" for social and political behavior and attendant policy responses, in *real* as well as *virtual* contexts; (c) imperatives such as these converge around matters of *sustainability* when considering contributions of technology to development; and (d) central to these processes is the role of *knowledge* and *knowledge networking.*

The argument is presented in two parts. The first section explores theoretical issues surrounding technology and development. The second part concerns the Middle East and focuses on development challenges and attendant technology implications in two domains: the *traditional* "real," or physical, domains of water and energy, and the *new context* of "virtual" arenas created by advances in information technology.

II. Technology and Development

A. Global Contexts

1. Globalization Matters

In the course of many centuries, a major "architectural" alteration of the international system occurred as populations expanded their activities and political entities broadened their reach. By the close of the 1980s, it was already clear that economic and political activities in the world were undergoing an unprecedented transformation, a fundamental shift, perhaps even the beginning of a new economic order. That ongoing globalization may well constitute the greatest challenge to world populations since the end of Western European feudalism, which led to the Congress of Westphalia and the establishment of the "state" system as the most authoritative mode of governance.

If there is one common set of considerations found in all discussions of globalization, it surely must be "who gets what, when, and how"—the standard definition of politics for all societies at all times. This simple phrase harbors implications of each of the individual terms. "Who" refers to those counted as relevant in the situation at hand. "Gets" refers to rights and entitlements as well as access to things of value. "What" points to the stakes, gains, or utilities at hand. "When" is the matter of timing. And "how" refers to the process that takes place and, more importantly, the nature of the process.

Within the broad scholarly community can be discerned two dominant views of globalization: (1) a traditional understanding that focuses largely on *economics and economic transactions*, and (2) an emergent view that stresses the *complexity* of globalization and the interdependence among its multiple critical dimensions.

The traditional view defines globalization as the increased integration of national economies in terms of input, factor, and final product markets. Much of the related scholarship focuses on intra-state impacts and state-based responses, including matters such as policy coordination, divergence, and convergence. This economy-centric view, clearly important, appears somewhat restrictive in today's global context, and obscures many of the more pervasive system-transforming features of globalization. It also impedes a full appreciation of the extent to which globalization impinges on modes of governance and induces new pressures generated by sociopolitical and economic transformations.

By contrast, the emergent perspective seeks to understand the complexities engendered by interactions among dimensions of globalization, which are driven by significant flows of populations, goods and services, effluence and influences, and so on, across state boundaries. This view examines impacts of cross boundary flows along a feedback-type of "causal" chain, *i.e.*, from flows to impacts on national *structure*; from structural changes to the impacts of international *processes;* and from process-effects to the consequences for international *structure*. The essence of today's globalization is highly complex. It centers on the formation of common and overlapping policy spaces and shared institutional responses.

Some of the complexities of globalization are illustrated in the structures and processes listed in Table 1. These include economic, demographic, strategic, communication, and environmental factors, as well as endogenously shaped institutional responses. Today's complex globalization involves increasing integration of input and final product markets as well as activities and processes. It highlights the contextual and structural factors engendered by cross-border economic activity (for example, the economics of the international petroleum industry) and then draws attention to the emergent processes (which, in the Middle East, can be traced to the evolution of the consequences, such as oil exports and attendant financial flows, remitted earnings, etc.).

The resulting institutional challenge thus centers on the formation of common and overlapping policy spaces for shared responses to emergent dilemmas. Table 1 is illustrative, not inclusive. It is indicative, not exhaustive. Interestingly, every one of the dimensions in Table 1 is rooted in, or influenced by, technological change. It reminds us that "everything is related to everything else."[1]

2. Dominant Deprivations

In this context, *deprivation* refers to people persistently lacking: (a) requisites of basic survival; (b) access to opportunity; and (c) prospects for expressing their "own voices." Of these, the first is most essential. Without survival, matters of opportunity and expression are of limited relevance. One common statistic sums up the survival situation: about 1.2 billion people each live on one dollar a day. This statistic, however, masks even starker realities about daily life. According to the United Nations, life expectancy at birth for the least developed countries is

Table 1 Illustrating the Complexity of Globalization

•**Demographic Dimension**—Shaping Identity and Ethnicity	
	Population attributes
	Characteristics of labor markets
	Types of voluntary vs. induced migration
	Implications of demographic composition
•**Economic Dimensions**—Creating Livelihoods and Well-Being	
	Nature of production processes
	Technological features and choices
	Types of capital transfers and trade
	Modes of investments, transactions, and finance
	Patterns of consumption and import shifts
•**Strategic Dimensions**—Affecting Security and Stability	
	Security of the state
	Regime and governance security
	Global and environmental security
	Security as survival
•**Communication and Connectivity**—Creating Actors and Networks	
	Physical, virtual, and social networks
	Type and value
	Extent of reach
	Scale and scope
•**Environmental Dimensions**—Influencing "Nature" and its Assets	
	Atmospheric dislocations
	Terrestrial damages
	Water degradation
	Transmission of damages
	"Traveling traumas"

50.5 years, in contrast to 76.9 in North America and 73.3 in Europe. Infant mortality among the least developed countries is 99 per live 1,000 births; in North America, it is 7 per 1,000; and in Europe, 12 per 1,000. These figures are for 1995–2000.[2]

Despite differences in views and perspectives, it is unlikely that anyone would dispute the basic message about the pervasiveness of deprivation.[3] Much of the politics surrounding these issues boils down to whose views matter. Expression and participation in the political process are necessary prerequisites for shaping the policy spaces through which the stakes are determined and apportioned. Marginal populations seldom participate in public debates nor is the necessity of their participation regarded as an essential component of national pol-

itics. If prospects for participation are dim, then this will inevitably undermine any potential for further improvements in either basic survival rates or access to opportunities. This highlights the potential for "voicing" that, coupled with involvement in the political process, is a necessary requisite for reducing deprivation and enhancing conditions of basic survival.

This logic is empowered by one of the most significant features of the technological advances that created electronic connectivity worldwide. It is through connectivity that voices can be heard, and it is when voices are heard that the first step toward effective participation is taken. This is especially relevant given the growing attention — at global and local levels — to technological opportunities, to potentials for "leapfrogging," to avoiding the presumption that "one size fits all" when it comes to development strategy, and to the quest for sustainable development.

3. "Sustainable Development"

Defining sustainable development has become something of a cottage industry — perhaps even a large-scale industrial enterprise. While there are differences in how sustainability is defined or what its features might be, there is common agreement about what it is *not.* Sustainability is not unrestricted growth; not polluting investment activities; not poverty or deprivation. It is not unlimited expansion; not exploitation of resources; not unabated population growth or energy use. And the list goes on. More recently, the term *sustainable growth* has been used to amend the initial concept or perhaps to reintroduce the core concept that *sustainability* was designed to avoid, namely, *growth* per se.

I define sustainable development as the process of meeting the needs of current and future generations without undermining the resilience of the life-supporting properties or the integrity and cohesion of social systems. This view centers on human activities in social systems as its core focus, while taking into account and respecting the imperatives of nature and natural systems.

Extending this definition, it can be further differentiated in terms of: (a) respect for environmental and ecological viability; (b) the quest for less polluting or "cleaner" types and forms of economic activity and output; (c) viable modes of governance and politics; and (d) adaptive institutional capacity and performance.

Moreover, to become sustainable, I postulate that a system must meet four "conditions" (the quotation marks are to remind us that we are dealing with processes, not discrete outcomes). These consist of: (a) ecological systems exhibiting balance and resilience; (b) economic production and consumption that do not undermine the resilience of ecological systems; (c) governance modes that reflect participation and responsiveness; and (d) institutional performance that demonstrates adaptation and feedback. Finally, I posit that if, *and only if,* these conditions hold true will a system dispose toward sustainability.

B. Technology Matters—Roots in Knowledge

1. Defining Technology

Webster's New College Dictionary provides a variety of definitions for the word "technology." Among these are "applied science," "technical means of achieving a practical purpose," and "the totality of the means employed to provide objects necessary for human sustenance and comfort." Clear as these definitions might appear, they obscure some fundamental features of this general phenomenon that is termed technology.

I define technology as the application of knowledge and skills — organizational and mechanical — for the pursuit of individual and social objectives.[4] Each word in the previous sentence highlights some feature or dimension of technology. In other words, our overall understanding of the term becomes greater than the sum of its individual parts.

More specifically, this means that we are concerned with (a) applications, not theory or concepts; (b) knowledge and skills—not limited to equipment, hardware, or physical machinery; (c) the organizational and mechanical—not one or the other, not only the uses of equipment, etc., because organizational performance is itself a form of technology; and (d) the pursuit of goals, implicit or explicit, not a set of random activities. At the heart of this definition is the concept of *knowledge.* And, it goes without saying, knowledge is a necessary precursor for enabling technological applications.

2. Knowledge Foundations[5]

Turning to *Webster's Dictionary* once more, to "know" is to "hold something in one's mind as true or as being what it purports to be . . . [this] implies a sound logical or factual basis [and it also means] to be convinced of." By extension, *knowledge* refers to the "fact or condition of knowing something with familiarity gained through experience or association; acquaintance with our understanding of a science, art, technique, condition, context, etc., [including] . . . the range of one's information and understanding to the best of abilities in place [as well as] . . . the fact or condition of being aware of something." Accordingly, what is "known" is that which is "generally recognized." I extend this standard view of knowledge to take into account a cluster of understandings that I refer to as a *knowledge system,* defined as:

> An organized structure and dynamic process generating and representing content, components, classes, or types of knowledge, that is (a) domain specific or characterized by domain relevance defined by the reader, user or consumer, (b) reinforced by a set of logical relationships that connect the content of knowledge to its value (utility), (c) enhanced by a set of iterative processes that enable the evolution, revision, adaptation, and advances, and (d) subject to criteria of relevance, reliability, and quality.

Among the most fundamental attributes of knowledge is that its acquisition and utilization follow a law of *increasing returns*. This means literally that the more knowledge is obtained and used, the greater is likely to be its value and utility to the individual (or group) user. Clearly, knowledge can no longer be viewed simply as a "residual" companion to the proverbial "technology factor" in the production function but as central to economic performance and in some sectors a driving force. In addition, this also requires learning *about* knowledge and how to *generate* knowledge of *relevance*. By extension, the potential for *strategic uses* of knowledge has, in turn, shaped new modes of knowledge management, giving rise to what is now known as "knowledge-networking"—a verb, a noun, an adjective, and a new mechanism for generated added value.

C. IT and Cyberspace

1. Connectivity for Sustainability

If there is a cliché that most aptly characterizes the competitive features of the world economy today it is the "global race for knowledge." Knowledge matters. And it matters a lot. The power of knowledge is, fundamentally, contingent upon the capacity to access, use, diffuse, and expand the knowledge that is available. This composite power is shaped by the interaction between the *content* of knowledge and the *value* of knowledge. Toward the end of the 20th century, we saw an expansion of computing power, a growth of worldwide electronic connectivity, falling costs of transmitting information, and the convergence of computing capability and telecommunications infrastructure. All of this has taken place very rapidly in the industrial world, and we now look at the potential contributions of information and communication technologies (IT) to social transformations in developing regions.

Writing in 2000, John Seely Brown and his co-author reminded us that Moore's Law—namely, that computer power available on chips will double every 18 months—has held over the previous decade. And there is little reason to anticipate that it may not continue to hold, at least based on past and present performance. He also reminds us of the "difference between atoms, a fundamental unit of matter, and bits, the fundamental unit of information."[6] More important is his observation that by understanding people as well as information technology, we can make better use of information.

While IT is obviously not a one-stop solution for developmental problems, it is a critical enabler whose deployment may make it possible for developing countries to avoid the material-based, environmentally damaging historical patterns of the industrial West. The logic for this argument lies in the reliance on knowledge and access to knowledge as the fundamental asset for development. Knowledge about "things" and processes as well as knowledge about technology is generally lagging in developing counties, and barriers to access through IT modalities are now well recognized. IT enables access to knowledge about cleaner production, improved uses of materials, better resource management, improved health measures, and so on, without experiencing first hand the environmentally damaging and unsustainable development strategies.

Knowledge for sustainability is about navigating uncharted terrain with new tools and uncertain maps. Most important of all, knowledge for sustainability is about broadening our understanding of the concept of sustainability and its implementation. In the last analysis, it is about cross-border collaboration and the management of global knowledge through evolving tools of knowledge networking. But there are important barriers that must be transcended in order to "harness the power of knowledge."

In principle, we would expect advances in IT to contribute to socioeconomic sustainability and development by facilitating access to knowledge and reducing barriers to information. The implications for transition to sustainability are captured by Brown's reference to four attributes of information intensity: de-massification, decentralization, de-materialization, and de-spatialization.[7] In other words, advances in information technology enable reduction of volume for materials in use, decrease propensities for centralization in communication and lines of authority, minimize use of physical and material properties of goods and services, and eliminate distance per se as a constraint on human communication.

2. Technology "Leapfrogging"

The World Bank, among other entities, recognizes the potential impact of knowledge access and information technology for facilitating technology "leapfrogging." Here, leapfrogging means avoiding the replication of the environmentally polluting industrial development of the West, and forging a development strategy that is informed by the knowledge gained over the past century. With the recognition of the environmental problems due to industrialization and other forms of human activities, the traditional and polluting model of growth was called into question.

The quest for sustainability is a direct product of this realization. But the economic model of sustainable development (in contrast to the model of economic *growth* defined as expansion of physical output) remains to be fully developed. Some features have been well articulated in both analytical and policy terms, but a fully coherent, integrated sustainability model is not in place. Unless and until the international community converges on a model of sustainable development that is coherent and internally consistent, the full prospects of technology leapfrogging will be not be realized.

The leapfrogging in question pertains primarily to technology choices and only secondarily to stages of economic development.[8] It is in this context that the role of information technology in the support of development strategies can best be viewed. More specifically, leapfrogging means doing new things in new ways as well as doing old things in new ways, as the World Bank aptly noted. The rapid rate of advances in information technology makes it possible for developing countries to position themselves at the frontier of technology. Reducing the barriers and strengthening the enabling conditions may provide the developing countries with unprecedented possibilities for leapfrogging and not re-creating the dysfunctionalities of past development trajectories.

3. Reducing Barriers to Knowledge-for-Development

What are the barriers to knowledge-for-development, and how can they be reduced? In my research program, I have focused on six major barriers obstructing the use of the Internet for facilitating transitions to sustainable development. I have proposed and experimented with six solution strategies. Noted here are the barriers and solutions. In the following section, I turn to specific implementation via one cyber-system, namely, the Global System for Sustainable Development (GSSD).

a. Conceptual challenges. The notion of sustainability still remains somewhat ambiguous, requiring more precision, but this should not prevent us from addressing the basic problems. *The solution is to develop a conceptual framework to guide our understanding of the overall issues from diverse perspectives.*

b. Explosion of information about sustainability. In both print and electronic forms, the information explosion is making it difficult to access what one needs. *The solution is to put in place a knowledge provision process, coupled with quality controls and reality checks.*

c. Infrastructure conditions and constraints. Digital differences between the rich and poor in all parts of the world continue to be significant features of current cyber-landscapes. *The solution is to establish mirror-sites and develop partnerships with knowledge providers in various parts of the world*.

d. The Internet is an English language tool in a world that is non-English speaking. There are fundamental differences in understand-

ing created by linguistic disparities. *A solution to this very real problem is to engage in multilingual knowledge networking in order to enable users and providers from various parts of the world to express themselves in appropriate language, idiom, and terms*.

e. The English focus coupled with digital disparities creates biases in the provision of knowledge. This means that the voices heard are mainly those from the "North," while voices from the "South" remain relatively silent. *The solution is a knowledge-workflow strategy that enables users in various parts of the world to engage in content provision following collaborative methods and common approaches while at the same time retaining their autonomy and independence.*

f. Cost and price. The economics of Internet access makes it difficult for most people in most places to participate in the new cyber domain. *The solution is a pragmatic, in-kind cost-sharing approach.*

These six barriers and attendant strategies for enablers and solutions are illustrated by implementation of the Global System for Sustainable Development (GSSD), in partnership with institutions in industrial and developing countries.

4. An Illustration: GSSD

As an Internet-enabled adaptive knowledge networking system—connecting networks of networks — GSSD seeks to facilitate the knowledge and policy contributions to the emerging quest for sustainability and viability on a worldwide basis. GSSD is designed as an integrated and evolving "cyberLibrary" to provide human-assisted advanced information technologies for meeting sustainability challenges in both the private and public sectors by enabling functions and services across stakeholder communities in all parts of the world.

Barriers to knowledge access, due in part to the digital divide between rich and poor, are among the most critical obstacles to development. In the industrial countries, electronic scientific publications contribute significantly to knowledge dissemination, and various electronic initiatives to popularize science are becoming more visible. Developing countries, however, are not able to obtain such access, and few international efforts are in place to reduce this particular feature of the digital divide. And if access to knowledge and to applications of information technology is impeded by technological, cultural, political,

economic, or other factors, then the imperatives of reality supercede the promises of technology.

More specifically, GSSD provides strategic e-linkages to allow both globalization and localization of knowledge. It supports top-to-bottom as well as bottom-to-top knowledge provision, communication, and innovation. It focuses on delineating the complex domain of sustainable development and differentiating between the various facets, theoretically and empirically. This unbundling approach permits us to see the individual pieces as well as the whole and very complex system.

III: The Middle East

A. Key Issues

1. A "Laboratory"

I now turn to the Middle East region in order to highlight key issues pertaining to technology-for-development. After a sketch of the region as a whole, I focus on technology that concerns energy and water. In a physical sense, these domains are very real. Human societies are critically dependent upon access to energy and the availability of water. My purpose, then, is to illustrate new thinking about the contributions of technology to development by connecting these two domains so essential to human survival.

The Middle East serves as a veritable laboratory of diversity in national experiences and public policies. Some general features are used, in "sound bite" fashion, to convey image, context, and content of the region as a whole. These generally include rapid population growth, a remarkably young age structure, extensive urbanization and forms of cross-border migration, oil wealth, water scarcity, strategic location, diverse religious and ethnic configurations and contentions, and, most fundamentally, continued relevance to the global economy.

Transcending such generalizations are salient differentials both within and between countries. There are rich countries and poor countries; rural states and urban states; religious polities and secular ones; mono-"crop" economies and more diversified ones. There are highly populated countries and countries that are sparse in population; some are highly politicized, while others are not. Some countries harbor a robust private sector, but most do not. Some welcome foreign investments, others do not. A few have reliable contractual regimes, but

most do not. Some of the countries are tightly connected to the global economy, but others are not. And there are many more differentials relevant to matters of globalization.

Table 2 points to some characteristic features of the region, using the same lens, or perspective, as in Table 1.

2. Stark Realities

The quest for sustainability is as important to the future of the Middle East as it is to all other parts of the world. As in other regions, technology choices and strategies cannot be addressed effectively without attention to sustainability concerns. There are as yet few, if any, systematic studies of sustainability challenges and opportunities in the Middle East, and none (to my knowledge) on technology strategies enabling development.

Furthermore, not one country in the region has addressed sustainability dilemmas, either in principle or in practice, and none have responded to globalization matters with any degree of creativity and/or innovative thinking, let alone action. None has made the connection between globalization trends, on the one hand, and implications for their own sustainability, on the other.

The region as a whole has continued to rely on the more traditional, material-dependent, energy-intensive technology strategies characteristic of the industry-driven development policies of the post-World War II period. These earlier policies assumed a powerful role for the public sector, predicated on the dominance of government, with political participation for building venues enabling political expression in public forums. At the same time, the focus on infrastructure development and physical structures was far greater than investment in education, the empowerment of individuals, or the development of civil society. Over time, this disconnect obstructed rather than facilitated the development of the region.

The UNDP report *Human Development in the Arab Region*, released in July 2002, is the first ever such assessment for the region. It presents a stark, even startling, view of the obstacles to development, and an uncompromising assessment of the constraints on individual expression imposed by the various forms of authoritarian political systems. At the same time, however, the report indicates that life expectancy has increased by 15 years over a three-decade period, and infant mortality has declined by two-thirds.

Table 2 Illustrating Complexity in a the Middle East

Dimension of Globalization	Characteristic Features of the Region
1. Economic Dimension	Characteristic dominance of resource extraction industries; barriers in access to water resources; dependence of external technology, skills, etc.; dominance of the public sector.
2. Demographic Dimension	Rapid growth and very young population; salience of large-scale labor migration; labor market interdependencies; role of remittances and impacts on economic and financial flows and balances; etc.
3. Strategic Dimension	Continued regional conflicts with potential for global implications (i.e. Arab-Israeli conflict; water related conflicts; settlements conflicts; civil wars; humanitarian-related conflicts); strong connections to matters of global security (i.e., the Gulf War); etc.
4. Communication & Connectivity	Constraints in physical networks, infrastructure developments; role of politics and government controls; underutilized IT assets; potentials for cyber-related interactions; etc.
5. Environmental Dimension	Growth in CO2 and other greenhouse gas emissions due to oil production and associated activities; cross-border environmental erosion and scarcities (water, desertification, pollution, ` `traveling traumas,'' etc.).
6. Institutional Dimension	Limitations in available organizational mechanisms to ``manage'' globalization dimension; limited attention to strengthening modes of economic and financial intermediation; limited independence of the judiciary; limited political participation.

The report argues that venues for development are severely impeded by the pervasive lack of tolerance for diversity or competitiveness, coupled with intolerance for any challenge to government policies or to the performance of the public sector. More specifically, three barriers to development are mentioned. They are the lack of political freedom, the low status of women, and the constraints on the development of, and access to, knowledge. This last factor is critical to matters of technology-for-development and central to the viability of societies everywhere, especially given the rapidly changing parameters of the 21st century.

The remainder of this essay concentrates on development challenges and attendant technology implications in two domains: the *traditional* real, or physical, domains of water and energy; and the *new context* of virtual arenas created by advances in information technology.

B. Energy and Water

1. Critical Interconnections

Everyone recognizes that safe and secure access to water and energy are critical to development, anywhere and at any time. This is true for Middle East countries individually as well as collectively. In this region, however, energy and water are technologically interlocked yet they are treated as if they are independent of each other. As a result, some important enabling opportunities are missed. The potential coupling of their strategic responses can yield substantial benefits for water alone, for energy alone, or for the economy as a whole. The interconnections are structural as well, in that energy resources are used for the production of water, and technology dependence in the energy domain is directly added to the technology dependence on water.

For many countries of the region, the abundance of energy is a major source of revenue, a fundamental input in economic activity, and the basis for most of the region's programs and policies. Its abundance, a defining characteristic of the region, is a key element in geopolitics, regionally and globally. For other countries, energy is an indirect source of revenue in that oil sales translate into payments for the employment of labor, which result in earnings to support families back home that often appear as remittances in the recipient country's balance of payments account.

By contrast, water is scarce nearly everywhere in the area. As with energy, it is a needed input into socioeconomic development and a persistent source of concern for policymakers, locally, nationally, and regionally. Water, in all its forms, is a need of significant proportions. Finally, in a real, not a figurative sense, the region as a whole remains hostage to foreign technology for its economic development. It also depends on foreign innovations in these two domains so fundamental to basic survival.

2. Traditional Technology Biases

Energy and water are strategic and fundamental resources. Drawing upon the region's comparative advantage to develop new and innovative ways of capturing the potential gains (or value) is more a necessity than a luxury. Many of the assessments about energy and water in the Middle East are shaped by four biases that together contribute more to distortions of basic realities than to effective insights for strategic technology choices.

First, in the energy domain, the traditional outlook on technology development is dominated by the scarcity perspective of industrial countries, and by models that presume energy to be a fundamentally scarce resource. As a result, the dominant perspective is one of shortage. The shortage bias is simply wrong for the region. Energy sources and supplies are readily available, if not abundant, but poorly utilized due to prevailing price policies, management strategies, and limited integration with other sectors on an economy-wide basis.

Second, in the water domain, conventional assessments suffer from a set of biases that focus on natural sources rather than on the manufacture of water so dominant in the region. Given the singularity of the region's profile as well as the lack of relevance to the industrial economies, there are few integrated models of water supply and demand or effective water management policies that enjoy both robustness in analytical features and relevance to the realities of the region and its water parameters. The irrelevance bias severely impedes the usefulness of existing models and methods for water management. No other region of the world harbors economies whose basic survival depends upon continued access to manufactured water, which, in turn, is contingent upon advanced technology. A new look at technology for water is essential.

Third, and especially important, water and energy are always treated as separate inputs into economic performance, as separate resources, and as separate factors of strategic, economic, and political importance. Again, this separateness is imposed by the realities of industrial societies and not by the parameters of Middle East economies. In other words, there is a separateness bias that literally prevents access to the gains due to joint assessment and joint utilization.

Fourth, such perspectives are especially serious as they obscure the potentially powerful impacts of joint management of energy and water as individual parts of a combined resource base whose whole is significantly greater than its individual parts. This means that the value of water and energy carry a significant downward bias.

These four biases distort current understandings of technology-for-development. They also obscure the potential power of energy and water as strategic resources in the Middle East. While much attention is devoted to energy, relatively less is given to water. Research and Development (R & D) investments committed to water production and the expansion of supply are small compared to R & D for energy. Over time, the lack of such initiatives adds direct costs to the economies of the region, further increasing the true costs of water. By underestimating their strategic interconnections, major technology opportunities inherent in the development of markets in new technologies for both water and energy are overlooked. Notable among these are new technologies for water production, recycling, and conservation.

3. New Technology Opportunities

Since few of the usual policies for managing energy as a strategic resource in the West have been considered relevant to water in the Middle East, joint management of water and energy is constrained by the absence of known measures or experience in the West. While industrial countries may not find acceptable returns on water-related R & D investments (given the absence of a global market for water-generating technologies), this reality says nothing about the potential of such technology for the economies of the Middle East. Such potentials are shaped by one clear fact: the return on R & D investments in water technologies would, in fact, be tied to the built-in demand for water in the region, closing the supply-demand gap and ensuring return on the investment.

The Middle East as a whole is a natural market for water-generating technologies and for the production of water, based on various different technology models. Moreover, the co-development of energy and water strategies generates parameters that are fundamentally more pervasive than for energy or water alone. This "jointness," in turn, creates new opportunities for R & D, fostering new technologies targeted to a market already in place. Investment in water technologies—at the frontier of know-how — can yield products that are targeted to the Middle East market itself.

The size of the market, implicit and explicit, is sufficiently large to warrant the initial investments. The reduction of investment risk could be accompanied by strategies to diversify the distribution of risk and its overall composition. By extension, it would increase the range of potential new water technologies — for production, recycling, and/or conservation. Moreover, the technical spill-over effects, in terms of skill formation, capacity-building, and overall institutional and related management skills, extend beyond the water domain and have direct as well as indirect effects on the region's overall human skill portfolio. This process provides foundations for built-in new generation technologies and activities tied to water resource management and water-related technologies, thereby creating positive feedback (self-generating) dynamics of technological development.

C. Information Technology

1. Virtual Domains

Clearly, there is little reason for developing countries to replicate the IT trajectory of the past decades. Rather, it makes sense to identify the best choices at present generations of technology and prospects for future developments. There may be some important advantages to latecomers and some valuable lessons from the experiences of others. The same information-access service may be provided to users in different ways and with different infrastructures, depending on relevant conditions. For example, it is not necessary to build China's information technology infrastructure by putting in place physical wires from one end of the country to the other if the same service can be provided through other means, notably wireless modalities.

Few comprehensive studies exist about the penetration of IT in the Middle East, its deployments, uses, implications, and overall effects,

direct as well as indirect. Indeed, the potentials for IT contributions to the development of the region remain entirely uncharted. Returning to Table 2, which looks at the region from the same perspective as Table 1 (through the lens of globalization), the focus is now on the sixth row, on communication and connectivity, and hence information technology.

The previously cited UNDP report on *Human Development in the Arab World* makes a special point of acknowledging the regressive impact of contemporary conditions, the limitations in educational policies, and the notable lack of improvement in the overall human capital of the region. The other countries of the Middle East which were not the subject of the UNDP report (Israel, Iran, and Turkey) may be relatively better equipped to manage the challenges of globalization and attendant technology imperatives. They are also more proactive in their investment in knowledge-building skills, and hence in human capital.

Observers and analysts of the region tend to agree that "reading books" is not a powerful cultural imperative in Arab countries (or other countries of the region) nor is access to knowledge the most salient driver of development. Nonetheless, it is only fair to report that few incentives are in place to encourage intellectual curiosity or to channel the quest for knowledge into technologically innovative directions. For the bulk of the 20th century, the region has been constrained by various impediments to the easy access of information and to new sources of knowledge, broadly defined. Almost overnight, the creation of virtual reality and attendant spaces opened up new venues of access whose potential implications are yet to be fully recognized.

All governments in the region acknowledge the importance of cyber domains and, to one extent or the other, seem receptive to the new technologies. Yet economic factors combined with political realities have constrained diffusion potentials both within each state and across states. Indeed, the defining characteristic of virtual reality is its transcendence of boundaries, literal as well as figurative.

There are also technological constraints to IT uses in the Arab countries of the Middle East, over and above those traced to government sensitivity to criticism, that support a strong tradition of censorship. Major network bottlenecks, reinforced by limited investments in bandwidth expansion, are further exacerbated by government monopoly over telecommunication services. This provides powerful disincentives for attracting the needed infrastructure investments. The band-

width shortage is particularly pronounced in Internet linkages between the Arab countries themselves. The greatest deficiencies are in Libya, Lebanon, Syria, and Bahrain, while somewhat better facilities — possibly even ample supply of bandwidth — are available in Egypt, Saudi Arabia, and Qatar.

2. Rural Contexts and Distant Locales

A wide range of experiments have been done in various parts of the world about using information technology in and for rural communities. Numerous examples with, and experiences of, best practices have been recorded in this domain, but few, if any, refer to the countries of the Middle East. The proverbial rural-urban gap is salient throughout the region as governments continue to give preference to urban areas in development strategies.

Among the most prominent forms of IT for rural development are applications to (a) provide information about market conditions (to inform farmers of prices in adjacent or other communities); (b) support education programs (using icons as a means of communication in order to convey meaning without requiring the achievement of formal literacy); and (c) generate information that may affect their lives directly (such as locating cheaper access to materials of relevance).

Overall, the Middle East lags significantly in this regard. Investment in information technology for rural development is not flagged as a major priority. Interestingly, it is the non-governmental organizations from within the region that appear to take the most initiative in this area.

3. GSSD-Arabic

GSSD-Arabic is part of a broader international initiative seeking to enhance sustainability through connectivity, and, to the extent possible, to deploy the power of knowledge through multilingual knowledge networking. This strategy is based on an explicit recognition of, response to, and support for the very real fact of diversity — of cultures, differences in values, and variations in social and individual priorities—on a worldwide basis. In its Arabic language application, as in all others, the goals are to:

- Generate, support, and maintain an integrated and adaptive perspective on sustainability issues in all aspects of development
- Enable voicing of multiple views, diverse perspectives, and differing priorities from all parts of the world, as well as the provision of local knowledge in global networks
- Contribute to research and education on sustainability issues in diverse contexts
- Facilitate access to evolving cutting-edge scientific and technical information, applications, and innovations
- Provide support for participation in global debates by reducing barriers due to language, culture, and contexts, nationally and internationally
- Address and evaluate the effectiveness and implementation of global accords on development issues, particularly those pertaining to transitions toward sustainability

Given the need for continued updating, expansion, and development of new knowledge, the GSSD platform provides functions that protect consistency in the provision and deployment of knowledge. It may even help us keep track of the stock and flow of new thinking, scientific and social, related to sustainable development.

IV. Concluding Note

This essay began with a synthesis of globalization dimensions and debates, with special attention to matters of complexity, and then turned to knowledge and technology issues and the ways in which advances in technology create new spaces (literally and figuratively) and new forms of competition. The quest for sustainability in both social and environmental contexts can be seen as a necessary outcome of these complexities.

The Middle East region is particularly illustrative as a laboratory of socioeconomic and political diversity and is, therefore, instructive on matters of technology-for-development. In this context, I focused on two domains of human activity: (a) the *real*, manifested in material and physical terms, with reference to energy and water; and (b) the *virtual*, or cyber, domain, with reference to applications of information technology. Accordingly, I explored technology-for-development from

material as well as cyber perspectives, *i.e.*, the domains both real and virtual.

Technology-for-development is always a work in progress, literally and figuratively. The use of advances in information technology is also a moving target, again in both senses. This essay can best be seen as mapping increasingly important and complex dimensions of development in terms of challenges as well as opportunities. ◉

Notes

I would especially like to thank the respondents in our panel, Political Science professor Frank Adler and student Hande KolcakKostendil, for their insightful commentary.

1. It is reasonable to ask: When globalization "happens," in terms of one or more of these basic dimensions, how much of this change is reversible? If we consider reversibility in terms of "undoing" some process, then none of the dynamics implied in Table 1 can be "undone," not even in theory. If we consider reversibility in terms of a return to initial structural (or systemwide) conditions, then even this sense of the term is beyond the realm of reasonable conjecture.

2. United Nations, *Population, Gender and Development* (New York: United Nations Population Division, 2000), pp. 16–19.

3. More to the point, these figures represent basic survival under "normal" conditions. They do not take into account the miseries created by war, famine, drought, refugee status, environmental damage, natural disasters, etc. These conditions may have only tangential connections to globalization, as cause or effect, but their impact invariably exacerbates human miseries.

4. Clearly, there are multiple perspectives pertaining to technology, technology matters, and any aspect or issue related to technology. For the purposes of this essay, a transparent and behavioral approach is used, with a focus on the manifestations of knowledge and skills. While recognizing their existence, I do not dwell on historical, philosophical, engineering, cultural, epistemological, and other perspectives.

5. The literature on the domain of knowledge, broadly defined, generally uses a set of terms interchangeably to refer to roughly the same notion or set of notions. Among these are human capital, intellectual capital, manpower, human resources, and a variety of combinations thereof. As a result, important distinctions are obscured and their ramifications are lost in the process. The distinctions are between (a) the nature of the intangible, (b) the contents, and (c) the utilization by individuals or organizations. This distinction is not simply a matter of semantics for it bears directly on the embedded policy implications. For example, if one were concerned primarily with item (c), then the policy focus would be on institutional and organizational matters that might impede or facilitate acquisition, use, or diffusion of knowledge, irrespective of considerations of content or the conception of the nature of the intangibles.

6. John Seely Brown and Paul Duguid, *The Social Life of Information* (Boston: Harvard Business School Press, 2000), pp. 14–15.

7. Ibid.

8. This is an important distinction with far-reaching implications in theory and in practice.

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