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Water, Scarcity, Securtiy, and Conflict

Part I: Scarcity

Scarcity is the first strand—security being the other—of a double helix along whose intertwined curves lie the constituent elements of hydropolitical conflict. At the most basic level, actual scarcity may be said to exist when real demand (i.e. need) exceeds real supply. Although the maxims of supply and demand may determine actual shortages, the concept of water scarcity encompasses many discrete but interrelated factors that govern supply for any given demand (bearing in mind that demand, actual supply, and real consumption are not necessarily in alignment): climate, perceived and real need, quality (complicated by a wide variety of standards in river basins across the globe), location and reliability of source, consumption, technical capacity, accessibility, demographic growth patterns, distribution of population and water resources, efficiency, organization and management, use of fertilizers, loss and waste, extant, available, and safe-yield stocks of water, and policy decisions on the rate of consumption and distribution.

When considering supply, a distinction needs to be made between extant and available or safe-yield water. Extant (or existing) water is all surface and ground water, irrespective of quality or accessibility, known to exist. Safe-yield water is water that is actually available for consumption at a rate calculated to safeguard against too rapid depletion over a given time, say, fifty or a hundred years. There will always be a discrepancy between extant and safe-yield water because, for a variety of physical, chemical, and economic reasons, only a certain portion of a total existing stock will ever be extractable and useable.

Like the notions of security and conflict, how to define the concept of scarcity is the subject of a debate, perhaps not so much in terms of broad or narrow meanings, but broad and broader, because the parties to the debate appear to recognize that when scarcity refers to an essential resource such as water, which permeates virtually all human activities, it cannot be dealt with as a simple commodity. In economic terms, a resource is considered scarce "when demand exceeds supply at zero price....scarcity involves both the amount available and how society allocates that amount."[1] The broadest notions define resource scarcity as an ensemble of all those factors cited above interacting in diverse ways that limit supply in relation to demand, that constrain human activities, and can lead to tensions and conflict.

There is also a kind psychological scarcity—scarcity in the eye of the beholder. This kind of scarcity exists when, for whatever reason, people perceive or believe a shortage exists, whether the physical reality justifies the impression, and they behave accordingly. Perceptions of the amount and quality and availability of water are usually a part of a people's attitude toward the environment. Generally, the public tends to assume simply that quantity of water equals availability, while the reality is far more complex. Up to the recent past, aside from the experts, most ordinary citizens have been ignorant about all the factors that impact on water quality (or, for that matter, about the other multilayered compexities of water), and have shown a reluctance to admit that their own activities threaten water quality.

This attitude has been entrenched during this century, mainly because most of the parley on water has been technical, tending to objectify water as a commodity to be harnessed to generate energy, improve crop production, increase economic development, provide recreation, make more housing available, etc.; in this view, if water appeared to be an obstacle to development, it could be eliminated—an attitude that became more widespread in the modern era of colonialism and imperialism. However, the global environmental movement is slowly making inroads into this persistent attitude. Underlying peoples' concerns about water is a sensibility of hazard or insecurity about too little or too much water. Their perception of risk in these regards, real or ephemeral, is a direct determinant of water use and scarcity since people make their own decisions about how a water supply should be used, the safety of drinking water, the liklihood that a threat to a water source or quality will occur, and what demands to make on governments for allocations, rates and standards of use.[2]

Other factors can play an ancillary role. For example, when, because of environmentally induced scarcity, it becomes necessary to change consumption patterns and modes of production, affluent societies are better able to respond effectively and quickly than poorer nations who tend to suffer more consistently from these kinds of shortages and become locked into cycles of high population growth, stepped-up economic activity to sustain population expansion, increasing strain on water resources, and behavior that depletes the resource at an unsustainable rate or even destroys it. Because in such cirucumstances resource scarcity promotes social inequities, political tensions, state weakness, and authoritarian regimes, it is a determinant of both security and conflict, and must be envisaged accordingly.[3] Water and other associated environmental scarcities set afoot large-scale migrations from the countryside to the cities, creating large, dislocated, underemployed or unemployed floating multitudes, particularly in third world countries where this phenomenon is more typical, that become serious drains on the economy, create political hazards, and create a distortion in the national economic balance in favor of city over rural dwellers.

While there are numerous reasons for water scarcity, they all tend to be variations on six basic causes which, taken together, will delimit supply and demand: climate changes (principally drought), degradation of water quality by human activity at a rate faster than the souce can be renewed, depletion of a source such as an aquifer, at rate faster than it can be replenished, out-of-basin diversion or storage of surface water, redistribution for other uses or to another place, and consumption. In the Middle East, these causes stem, in one way or another, from a single overriding, immutable determinant of scarcity that accounts for the region's aridity—for that matter, the aridity of other parts of the globe as well: the way in which the earth functions as a stupendous heat pump run on solar energy which generates a constant process of intense evaporation within a broad zone that encompasses the Middle East region.[4]

Historically, patterns of consumption in this century indicate that the highest annual per capita withdrawals are associated with nations where both irrigated agriculture and industry are large scale and very advanced (e.g., the U.S. at about 2500 m^3). However, it does not follow that the opposite would be true for developing nations where industrialization is low, populations are high, soil quality is poor, and water is scarce—a set of circumstances that characterize large tracts of the Middle East. In those countries where the need for food production from irrigated agriculture is substantial, the tendency is for proportionately higher per capita withdrawal, as, for example, in Egypt (2000 m^3), Jordan (900 m^3), and Israel (1200 m^3).[5]

Over the past two decades, the trend has been a rising per capita withdrawal rate globally. Most of this usage goes into irrigation, particularly in poorer countries where an average of 85%-90% of available water stocks are consumed by agriculture, and as much as 75% can be regularly wasted and lost by inefficiency and primative methods. Poor nations use about twice as much water per hectare as wealthier countries but achieve yields that are only one third as plentiful. Evidence shows that the instinctive response of Third World governments to such situations is to borrow more money for the public financing of huge hydrological infrastructure projects such as dams, desalination plants, and irrigation systems, and to subsidize water, investment capital, and operating costs for irrigation schemes, and crops. It is not uncommon for poor, arid countries to expend 16%-17% of all public investment on water management. These policies create serious, long-term distortions into their economies from which recovery is extremely difficult for political as well as economic reasons, resulting in the loss of international credit ratings, making further borrowing difficult, and exacerbating poverty. When the World Bank discovered that Egypt was spending $4-6 billion a year on water subsidies, the Bank suspended loans to Cairo.[6] These are the circumstances that link poverty so commonly with scarcity in large regions of the world. The late Kenneth Boulding, the ecological economist and sometime rhymer captured the gist of this process in a few stanzas from one of his versifications, *A Ballad of Ecological Awareness*:

> The cost of building dams is always underestimated
> There's erosion of the delta that the river has created,
> There's fertile soil below the dam that's likely to be looted,
> And the tangled mat of forest that has got to be uprooted.
>
> There's disappointing yield of fish, beyond the first explosion;
> There's silting up and drawing down, and watershed erosion.
> Above the dam the water's lost by sheer evaporation;
> Below, the river scours, and suffers dangerous alteration.
>
> There are benefits, of course, which may be countable, but which
> Have a tendency to fall into the pockets of the rich,
> While the costs are apt to fall upon the shoulders of the poor.
> So cost-benefit analysis is nearly always sure
> To justify the building of a solid concrete fact,
> While the Ecologic Truth is left behind in the Absract.

Withdawals are a function of supply, distribution, demand and development which are driven by population growth. As populations rise, per capita supply (a rough index of water security) falls. Worldwide, between 1970 and 1993, the earth's human inhabitants increased by 1.8 billion. In the same time frame, the global average per capita water supply decreased by one third.[7] In the Middle East, the composite effects of poor supply, maldistribution and escalating populations are revealed in exponential discrepancies of water supply per person across the region, ranging from a per capita supply of 115 m^3 in Libya to as much as 5000 m^3 in Iraq (in rainy years). A disturbing related trend has emerged in recent decades: over the last 30 years, the average available supply of water for the entire Middle East has fallen rapidly from somewhat more than 2000 m^3 per capita to less than 1500 m^3 per capita.[8] Presently, 64% of all Middle Eastern countries are confronting serious water shortages. A persistent combination of destructive elements such as drought, overpopulation, economic and political instability, and a failure to settle regional conflicts, have plagued the region since the end of WW II and forestalled the large-scale cooperative effort necessary to manage the scarcity problem—a pattern that has contributed significantly to the dimunition of per capita supply. Given that the region has very little margin of safety where water supply is concerned—especially in face of a population that is projected to double within the next quarter century—unless this situation is reversed without further delay, several key actors in the major river basins—Jordan, Israel, the Occupied Territories, Egypt, Syria, and Iraq—face a series of destablizing economic and political crises within the foreseeable future, the consequences of which will reverberate throughout the region and in much of the western world.

Despite a moderate leveling off among some countries in the late 60s, the global withdrawal rate resumed an upward climb even in those countries where per capita consumption was already high or had overtaken supply. The world-wide phenomenon of peoples migrating to cities has had a dramatic impact on water supply and use. In the last half century, the massive, incredibly rapid shift of population from rural areas to urban centers—during the next forty years, cities will be the locus of 90% of the world's population increase—has resulted in a surge of water usage as population densities have increased and water uses have multiplied. These scarcity-causing trends have gradually given rise to more arguments for shifting water management strategies from "supply management" to "demand management." When shortages have loomed, the understandable (near-Pavlovian) response of authorities has been to expand supply somehow, but without altering demand. This approach remains prevalent. However, as water budgets have dwindled and costs of supply have risen in many countries, the focus of water management has tended to veer toward the *needs* of people and managing demand rather than on water itself.[9]

The complexities linked with the fact and concept of scarcity have inspired efforts to ascertain and measure shortfalls. One water specialist, Malin Falkenmark, has devised a rudimentary standard measurement by which to categorize nations as water sufficient or water-scarce. This prescription stipulates that countries are water-stressed if annual supples are no more than 1000-2000 m^3 per capita, and become water scarce when supplies drop to less than 1000 m^3 per person, that is, water shortage inhibits food production, economic development, and threatens public health.[10] Two other useful approaches, fairly representative of efforts to determine scarcity by quantities of water, are also useful. The first, a variation on the Falkenmark axiom, is cast as a "Shortage Index" and the second as a "Water Poverty Line." Both are based on a ratio of available renewable fresh water supply to per capita demand. Neither of these methods (nor any other) has been thoroughly field tested, and it must be borne in mind that in both instances, because supply and demand involve so many variables, and because the available data are frequently incomplete or inaccurate, the quantified results can only be taken as percentages of accuracy or orders of magnitude rather than actual figures; the conclusions may be rough-grained, but the verisimilitude is reasonably good.[11]

The Shortage Index is really a series of regional indexes that reflect four variables: 1) High ratio of demand to supply; 2) per capita water availability in relation to population growth; 3) per capita water consumption in excess of 1000 m^3/year; and 4) the ratio of external water supply to internal water supply.

By the first index, any country whose water withdrawals exceed one-third of its total renewable supply could be considered to be vulnerable to shortage depending on specific conditions, but particularly one with low levels of precipitation; in that country the water supply could be low or the demand high. Countries with semi-arid to arid climates that withdraw half or more of their renewable supplies are in definite risk of falling into deficit. Of the 21 countries examined that were found to fall into the high ratio of demand to supply category, twelve of them are in the Middle East and all are forced to import fresh water, overpump groundwater, or desalinate on a large and costly scale: they are Bahrain, Egypt, Iran, Iraq, Israel, Jordan, Kuwait, Libya, Saudi Arabia, Tunesia, UAE, and Yemen.

The second index takes into account evolving population growth patterns by means of the ratio of available water to the number of users over time. Specifically, countries where the annual available supply is projected to fall below 1000 m^3/person between 1990 and 2025. (An equivalent way of expressing this ratio is by determining whether more than 1000 people will have to be supplied out of each million m3 of water.)[12] Here again the nations of the Middle East are among the most susceptible to scarcity. Between 1990 and 2025, assuming current population trends, almost all Middle Eastern and North African nations will decline in per capita water availability by at least 50 percent, and some by even more: for example, for Egypt the figures run from 1100 m^3/year in 1990 to 600 in 2025, and for Jordan from 280 m^3/year in 1990 to 80 in 2025.

Under the third index—countries that use more than 1000 m^3/year per person—there are only four Middle Eastern countries: Egypt, Iran, Iraq, and Sudan, and in all but Iran, demand is close enough to supply that even moderate drought conditions sustained for more than a year would cause a negative ratio.

There are six Middle Eastern countries that fall within the fourth index—nations dependent for more than a third of their water supplies on transboundary water basins, that is, on external sources. These are Egypt (which receives virtually all of its water from outside the country), Iraq, Israel, Jordan, Sudan, and Syria. In every case the ratio of external to internal supply is greater than 1, which means that these countries are vulnerable to external political and economic forces.

A Water Poverty Line—which is another way of quantifying the issue of scarcity—represents the minimal amount of water needed to satisfy domestic needs on the one hand, and water requirements to produce food on an annual per capita basis on the other. A hydro-poverty line may be established in the following (step-by-step) manner:

1) Determine the average annual per capita supply of water by dividing the total available stock (S) by the number of inhabitants (P). This is factor A.

2) Add together the annual per person requirements for each sector—agricultural, domestic, and industrial—to arrive at the the total need. This is factor B.

3) To determine quantitatively whether scarcity exists and to what degree, divide factor A by factor B: the "water poverty line" will emerge at the quotient 1. If A = B only, or if A divided by B = 1 or less, then that country may be considered to be suffering "water poverty" (1 representing a marginal situation which would place the country in the poor category in semi-arid and arid regions). If the quotient of A divided by B is greater than 1, that country may be said to enjoy sufficiency or even a surplus, in which case it would be "water rich"; less than 1 indicates water poverty. To illustrate, first with the general formula, then using Jordan as a case study:

General formula:

Factor A = S (S is available water/yr in Mcm)

Factor B = P (P is population x R (R is water requirements

for all sectors in Mcm)

Thus: $\frac{S}{P \times R}$ = Water Poverty Line

Jordan (using 1991-2 data): $\frac{750 \text{ Mcm}}{3.4 \times 1250 \text{ Mcm}} = 0.176$

The following scales may be used for convenience: if A divided by B =

Water Poor		Water Rich	
1 - 0.75	poor	1 - 1.5	sufficiency
0.75 - 0.5	very poor	1.5 - 2.0	rich
0.5 - 0.25	extremely poor	2.0 - > 2.0	very rich
0.25 - 0	disasterous		

By this formula, Jordan is in a disastrous state since A divided by B = 0.176

However, there is another factor, C, which must be taken into account: dry farming (including meat production). If a portion of a country's food requirements are derived from dry farming, then that portion should be subtracted from the quantity of water needed to produce food by irrigation. If 33.3 percent of food demand is met by dry farming, as is the case in Jordan, and the annual per capita requirement of water for 100 percent food production is 1450 m^3 (real need), then 483 m^3/capita/year (0.333 x 1450) of water are saved by dry farming and must be subtracted from the total: that is, 100% - 33.3% = 67 % which will be needed to produce food that cannot be supplied by dry farming. In Jordan, taking into account dry farming (33.3%), the amount of water needed for irrigated agriculture is 967 m^3/capita/year (1450 m^3 - 483 m^3). When the 36 m^3/capita/year for M & I (municipal and industrial use) is added, the total becomes 1003 m^3/capita/year.

Now the water poverty line can be calculated using factor C, dry farming:

C is the total water demand for irrigated agriculture (adjusted for dry farming) and M&I: 1003 m^3 (967 m^3 + 36 m^3). By dividing the available water per capita (A) by the adjusted total (C), a more precise scarcity quotient may be obtained; in the case of Jordan that would be 281 m^3 divided by 1003 m^3 which equals 0.28, placing Jordan still considerably below the poverty line in the extremely water poor category on the above scale. Israel by this formula has a 0.4 quotient, slightly better than Jordan's but still relegated to the extremely poor level.

Using both approaches, A over B and A over C, allows for greater flexibility in reckoning scarcity. For example, Egypt has almost no dry farming, therefore A over B = A over C, while in Syria, which has large tracts of dry farming, A over C will be > A over B.

The effects of water scarcity, particularly serious chronic shortage, not only generate tension and cause conflict, but manifest themselves in other cross-cutting ways in virtually all sectors of society, most prominently in food production. The per capita water requirements for food production depend on such variables as climate, evaporation, irrigation efficiency, the use of fertilizers, etc. In the Middle East, the aggregatred annual per capita water needs for food production, reflecting arid climatic conditions and poor soil quality in much of the region, vary widely averaging between 900 to 2000 m^3 per person per year; for example, in Egypt the figure is about 2000 m^3 and in Jordan it is about 1000 m^3. Small wonder that the Middle East falls within the WANA zone where the largest food deficit in the world exists.

The impact of water scarcity on food production in the region is reflected in other ways as well. In a situation of medium level water consumption, it takes 1200 m^3 per year to produce enough food of all types to feed one person for a year at the rate of 2400 kilocalories. This calculation is based on an annual consumption of 100 grams of meat daily (or 35 kilos/mo./yr), 450kilos of vegetables and fruits, and 140 kilos of grain. In Jordan, owing to scarcity, instead of 1200 m^3 only 220 m^3 of water per capita per year are available for the purpose, forcing Jordan to bridge the gap by over-pumping water, importing food, and other expensive measures which place a serious strain on its very fragile economy.[13]

As seen, scarcity, especially mismanaged scarcity, contributes significantly to the creation of an environment of uncertainty and instability in the basic political, economic, and social institutions of society, most destructively in situations where the integral factors of ecological marginality and rising poverty obtain. This condition is most typical of developing nations where traditional societies in their efforts to enter the developed world, have stripped away their customary methods for coping with the dislocations of change, but have not as yet replaced them with the necessary combination of new institutions and technology. In the political realm, one salient consequence of this circumstance has been a reinforcement of authoritarianism. How a society responds to ecological scarcity is of fundamental importance because the corrosive effects that scarcity can have on the material underpinnings of social well-being can be a powerful determinant of whether that society will live under a democratic or authoritarian political system. One authority has summed up the issue this way:

"It follows that asssumptions about scarcity are absolutely central to any economic and political doctrine and the relative scarcity or abundance of gooes has a substantial and direct impact on the character of political, social, and economic institutions."[14]

For a country like Jordan, every water issue, current and projected, radiates from the overriding fact of scarcity. In Jordan the reality and concept of water scarcity are complex in both physical and human terms, and the most serious complications lie in the political and economic dimensions of insufficiency. All of the foregoing structural elements that define scarcity are integral to the political processes and riparian relationships of the Hashemite Kingdom and its neighbors.

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1 Johnston, G.M., "The Role of Economics in Natural Resource and Environmental Policy Analysis," *Natural Resource and Environmental Policy Analysis. Cases in Applied Economics*, Johnston, G.M., Freshwater, D., and Favero, P., eds., Westview Press, Boulder, CO, 19??, 2; see Gurr, "Political Consequneces of Scarcity," 54-55, for a variation on this definition; Ophuls, *op. cit.* 8-9 for a broad definition.

2 Cotgrove, S., *Catastrophe or Cornucopia: The Environment, Politics, and the Future*, J. Wiley & Sons, NY, 1982; Dunlap, R.E., Gallup, G.H., Gallup, A.M., *The Health of the Planet Survey*, G.S., Gallup International Institute, Princeton, May 1992; White, G.F., "Formation and Role of Public Attitudes," Kates, R.W., and Burton, I., eds., *Geography, Resources, and Environment*, vol. I, Univ. of Chicago Press, Chicago,

1966, and Whyte, A.V.T., "From Hazard Perception to Human Ecology," *ibid.*, vol. II, Chicago, 1986.

[3] Mathews, "Redefining Security," 162-77; Gurr, *op. cit.*, 55-58; Ophuls, *op. cit.*, 8-9; Postel, Sandra, *The Last Oasis. Facing Water Scarcity*, Norton, New York, 1992, chs. 1 and 2.

[4] Kolars, John, explains this process in a little more detail in "The Course of Water in the Arab Middle East," Arab-American Affairs, Summer 1990, no. 33, 59 (DB# 5326).

[5] See, for example, Tables 1 and 2 in U.N., #5439, 4, 6.

[6] *The Economist*, March 28, 1992, 11-12.

[7] Postel, *Last Oasis*, 28-29.

[8] These data emerged at a seminar on water and the multilateral peace negotiations held at the Department of State April 1-2, 1993; see also Kolars, J., "Water Resources of the Middle East,"*Canadian Journal of Developmemnt Studies, Special Issue : Sustainable Water Resources Management in Arid Countries*, 1992, 103-106,and Tables 1 and 2; and Tvedt, T., "The Struggle for Water in the Middle East," in *Ibid*, 14-33.

[9] U.N., DB #5439, 5, 61, 169; Postel, Sandra, "Water on Tap or Down the Drain?" *The Futurist*, March-April 1986, 18; on demand management, see Naff, T., "A Case for Demand-Side Water Management," forthcoming in the proceedings of the First Joint Israeli-Palestinian Conference on Water Problems in the Middle East, Zurich, Dec. 1992, to be published in 1993.

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[10] "Fresh Water—Time for a Modified Approach," *Ambio*, v, 15, no.4, 1986, and "Global Water Issues Confronting Humanity," *Jounal of Peace Research*, v. 27, no. 2, May 1990, 177-91, and "The Massive Water Scarcity Now Threatening Africa—Why Isn't it Being Addressed?" *Ambio*, v.18, no. 2, 1989; see also Postel, *Last Oasis*, 28-29.

[11] The Shortage Index has been devised by Peter Gleick, "Vulnerability of Water Systems," in P.E. Waggoner, ed., *Climate Change land U.S. Water Resources*, New York, 1990, 223-40, and "Water and Conflict," unpublished paper presented to the workshop on Environmental Change and Acute Conflict, University of Toronto, June 15-16, 1991, 8-10 and tables I-IV. The Water Poverty Line index has been devoloped by Professor Elias Salameh, Director of the Water Research and Study Center, University of Jordan, Amman. Professor Salameh has not yet published his index, but kindly sent me a draft.

[12] Falkenmark, M., "Fresh Water - Time for a Modified Approach."

[13] The data is drawn from the FAO, the Jordan ministries of Agriculture and Planning, and from discussions with Boulous Kefaya, Director of Infrastructure, Ministry of Planning, Jordan, whose remarks on this matter are based on the work of the Minister of Agriculture.

[14] Ophuls, William, *Ecology and the Politics of Scarcity. Prologue to a Political Theory of the Steady State*, San Fransisco, 1977, 8, also 142-198, 200-244.