Reflections on the cost of water and Mideast peace

There is no limit to the fresh water that can be supplied to the Middle East and Northern Africa. Jonathan Tennenbaum of Germany's Fusion Energy Forum analyzes the economics of water.

Whether or not the follies of the Bush administration ignite a new war in the Middle East, two fundamental facts concerning this region remain unchanged and unchangeable: 1) There can be no lasting peace without real economic development for the majority of the people living there. 2) Economic development in this region depends most crucially on *water,* or more precisely on the improvement of fresh water supplies and water management systems.

Lyndon LaRouche has developed these points in a series of recent statements on the Middle East crisis, in which he proposes relaunching economic development through infrastructure projects, with emphasis on large-scale water projects for "greening the deserts." This article explores some of the fundamentals of the economics of water, with reference to the Middle East and North Africa. In the process we develop data and concepts which will be of value in further deliberations on this topic.

Water and population potential

Like every other living organism, a physical economy depends for its continued existence upon an increasing throughput of water, of generally improving quality as well as quantity. While the absolute minimum water intake for the survival of an adult human being is biologically fixed at about 2-4 liters of fresh water per day, the per capita throughputs of fresh water required by an economy at modern levels of living standard and agricultural and industrial productivity, are some three orders of magnitude higher (see **Table 1**).

Just growing the food to feed one person requires (depending on climate, form of agriculture, and diet) an average of 2-6 cubic meters (2,000-6,000 liters) of water per day. In Central Europe and the eastern United States, for example, nearly the entirety of the water required to grow food is provided directly "free of charge" by relatively regular rainfall; in much of the Mideast and North Africa, apart from coastal areas with "Mediterranean climate," the possibility of agriculture depends upon extensive irrigation and water management systems. To this is added the growing requirements of industry (see **Tables 2** and **3**). Neither the requirements for water, nor the magnitude of fresh water throughput which can be generated per capita to support economic activity, constitute fixed or bounded magnitudes. Both grow as a function of the per capita productive power of society. "Productive power" means that self-expanding power of man over nature, whereby man increases the relative potential population-density of the human species. That means, roughly, the density of population which can maintain itself per unit surface area of any given territory (see discussion of this topic in LaRouche's book *In Defense of Common Sense,* Schiller Institute, Washington, D.C., 1989).

The mastery of the fresh water supply is a crucial singularity in the expansion of man's productive power. How much water do we require per square kilometer of a given territory, in order to maintain a given population-density at a given level of per capita productive power? And how is that productive power applied to man's growing mastery of nature, to the effect of generating increasing quantities and qualities of water throughput per square kilometer and per capita? Such improvement in water supplies provides the foundation for realizing a higher level of productive power, in a self-expanding negentropic process. Scientific and technological progress are the means by which that expansion is accomplished.

TABLE 1

Water requirements in an industrial economy: West Germany, 1980

Use	Liters per capita per day*	Remarks
Households:	140	Highest quality
Bathing	20-40	
Laundry	20-40	
Toilet	20-40	
Other hygiene	10-15	
Housecleaning	3-10	
Dishwashing	4-7	
Drinking and cooking	3-6	
Industry (excluding public utilities power generation)	565	Varying qualities
Power generation by public utilities (coolant water)	1,392	Low quality
Agriculture		
From rainfall:		
Direct water throughput of agricultural plants (transpiration)	2,740	
Rainwater lost by ground evaporation, runoff, seepage	383	
From public supplies: Water for livestock, irrigation, etc.	23	
Other public and private uses	14	
Total including direct rainfall	5,257	
Total excluding coolant water for power generation	3,865	
Total excluding direct rainfall and coolant water for power generation	742	

*1,000 liters=1 m^3=264 gallons

TABLE 2

Water consumption in Israel, 1983

Use	Liters per capita per day*
Agriculture	911
Industry	70
Household and other	270
Total	1,251 liters=1.251 m^3=329 gallons

Supply of water per se

Two remarks should be added to define the nature of water requirements more precisely.

First, the function of water lies in its *flow*, or *throughput*, not in any intrinsic property of water as a static object. To realize this we have merely to reflect on the function which water serves in a living organism, an economy, or the biosphere. This seemingly trivial idea embodies a profound truth, that substance exists only as *activity*. Primitive substance is nothing but *efficient negentropic action*, and nothing exists in an economy or in the universe apart from negentropic action and singularities derived from such action. What we call water is nothing other than a specific form or species of *activity*—and similarly for all those things which are often spoken of, incorrectly, as "limited resources."

The thirsting man does not actually thirst for water, but for the *flow* of water—the flow which threatens to be interrupted when the outflow of water from his body is not matched by the inflow. (Salty water does not help him be-

TABLE 3

Examples of specific water requirements

Use	Without recycling	With recycling*
Minimum water consumption for growth of plant tissue	250-1,000 kg (0.25-1 m^3) of water throughput for each kg of plant tissue grown above surface	
Water required by a field to grow a ton of wheat, under Central European climate conditions (low evaporation)	500-1,500 m^3	
Average amount water supplied to irrigated land in Israel	5,300 m^3 per hectare per year	
Irrigation water required for growing cereals in desert (rainfall nearly zero)	8,000-10,000 m^3 per hectare per crop	
Water needed by a milk cow per day	50 liters=0.05 m^3	
Steel production	220 m^3	5-15 m^3 per ton
Paper production per ton	400 m^3	120-190 m^3
Coal mining per ton (anthracite)	25 m^3	2-3 m^3

*A variety of methods have been developed for reducing the rate of evaporation from soil and transpiration of plants, as well as recovering and recycling water through drainage and capture of water vapor in closed enclosures. By these means the net water requirement can often be reduced, at the expense of higher investments and running costs per unit area. The specific data are too complicated to go into here. It is important to note, however, that the reduction of water consumption per unit produce goes hand-in-hand with increasing the yields per hectare, i.e. with increasing intensity of agriculture.

cause its osmotic pressure blocks the flow of water into his tissues.) Thus, in an economy we are interested in the *useful throughput* of water per unit time, surface area, and per capita of the population.

The second point, implied in the term "useful throughput," is the requirement, that the flow of water possess certain qualities of organization in space and time. In many areas of the Mideast and Northern Africa, for example, precipitation is highly irregular and often takes the form of brief, torrential rains separated by long periods of nearly zero rainfall. Apart from overcoming the relative scarcity of fresh water overall in this region, we require water management systems to ensure a regular flow of water in the amounts and locations where it is needed, when it is needed. The control of the age-old flooding of the Nile, by the Aswan Dam and other measures in Egypt, illustrates this principle. In Turkey, where annual rainfall varies between 250 mm and 2,500 mm, more than 100 major dams have been constructed. According to official Turkish estimates, a total of approximately 500 dams and 430 hydroelectric projects will be needed to regulate Turkey's rivers and make full use of the natural rainfall.

There is no intrinsic limitation on the fresh water throughput which can be supplied, even to the desert regions of the Middle East and Sahara. The potentials of modern technology demonstrate this very clearly. (See also the examples described in *EIR*, Sept. 28, 1990, "Water projects for the Mideast, Africa.")

1) Fresh water can be transported by pipeline and canals, from areas of higher rainfall—such as the highlands of Turkey, the source areas of the Nile, and the Congo basin—into arid regions. **Table 5** indicates the huge amounts of fresh water which presently flow, "unused" into the ocean, from the Congo basin in particular. Nuclear excavation techniques permit canals and basins to be rapidly dug at a fraction of the cost of conventional techniques. By a combination of pipeline and conduits, canals and pumping stations, fresh water can be delivered over thousands of kilometers. Large-scale piping of fresh water is already done in California, for example.

2) Using state-of-the-art technology of reverse osmosis, we can generate fresh water from seawater at the "energy cost" of about 3 kwh of electricity per cubic meter of fresh water produced. When electricity generation is combined with desalination, as can be done most advantageously with the high temperature reactor, the "waste heat" from the generation process can be put to work in desalination, also. Thereby, a handful of nuclear power units rated at 5-6 gigawatts total electric output, would provide enough power to produce a fresh water flow equivalent to the Euphrates River! (See **Tables 4** and **5**.)

3) Desalinated or raw seawater can be delivered from sea level to any elevation by pipelines and pumping stations. For example, it requires 1 megawatt of electric power to pump a flow of 1 cubic meter a second over an elevation differential of 100 meters. This is hydroelectric power "run in reverse."

TABLE 5

Mean flows of major rivers at point of discharge*

River	Flow m^3 per second
Amazon	120,000
Congo	61,000
Ganges-Brahmaputra	35,000
Yangtze	35,000
Niger	30,000
Zambesi	20,000
Jenissei	19,600
Mississippi	19,000
Lena	17,000
Ob	12,600
Mekong	12,000
Parana	11,000
St. Lawrence	10,000
Volga	8,060
Danube	6,430
Indus	5,700
Nile (at Aswan)	2,600
Nile (at Delta)	1,600
Rhine	2,450
Murray	1,900
Po	1,720
Rhone	1,240
Vistula	930
Euphrates	760
Elbe	710
Flow of desalinated water corresponding to electric power input of 1 GW (assumes best state-of-art value with reverse osmosis, 3 kwh per m^3, but not counting use of "waste heat.")	92

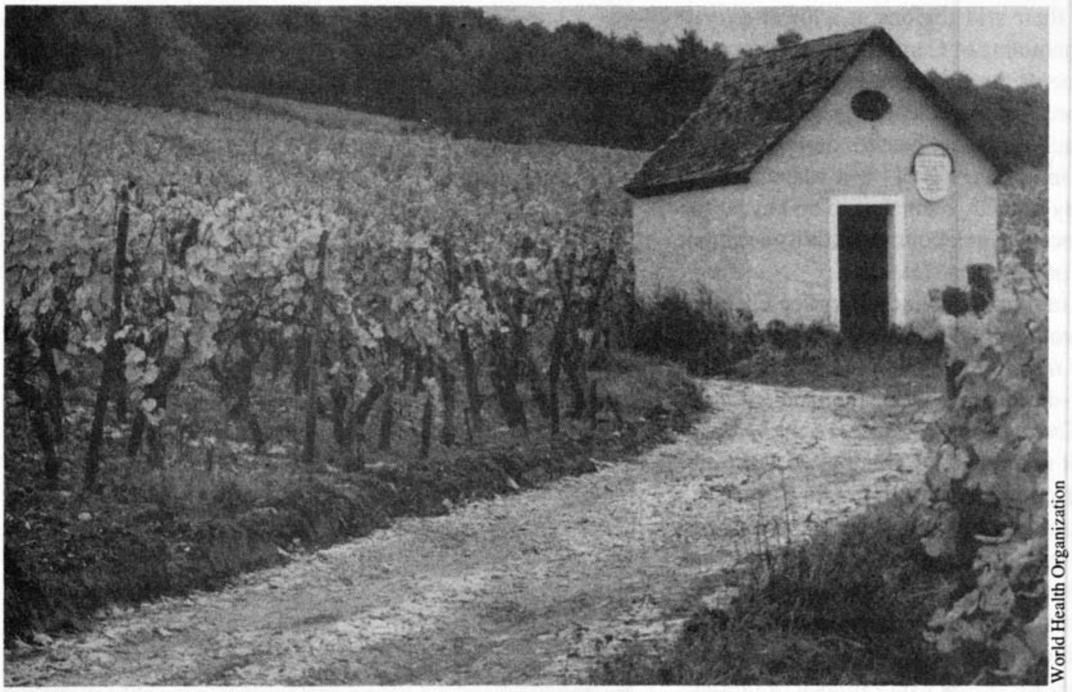
*This does not include water which has been "consumed" by evaporation, seepage, irrigation and other uses upstream of river discharge. The ratio of river water usefully consumed, to fresh water lost into the sea, differs greatly from river to river.

TABLE 4

Examples of unit cost of fresh water

(Approximate figures based on 1987 dollars)

Example	Cost per m^3	U.S. mills per gallon
Municipal water supply of Munich today	$ .50	1.9
Average cost of water in Saudi Arabia (at present mostly from ground water)	1.25	4.7
Price for desalinated water in Saudi Arabia today	5.00	19
Projected total cost of water via "Peace Pipeline" from Turkey to Saudi Arabia (capacity 2.5 million m^3 per day)	1.50	5.7
Cost of water desalinated using high temperature reactor/reverse osmosis combination (projection for 100,000 m^3/day plant)	1.25-1.60	4.7-6



A vineyard in Germany's Rheingau shows the abundance that can be produced with sufficient water. Just growing the food for one person requires an average of 2-6,000 liters of water per day. In Central Europe and the eastern U.S., nearly the entirety of the water required to grow food is provided directly "free of charge" by rainfall; in much of the Mideast and North Africa, agriculture depends upon extensive irrigation and water management systems.

4) Through pumping and water treatment, the vast accumulations of fossil water, and other ground water under the deserts in Saudi Arabia, in the Sahel and elsewhere can be tapped. (Note: much of the accessible fossil water is heavily mineralized, and requires treatment akin to desalination of seawater.)

5) The electric and thermal power required by various water treatment and pumping operations is available in virtually unlimited quantities, through the technologies of, first, nuclear fission, and later, nuclear fusion. The latter technology permits us to generate from the trace deuterium (in the form of heavy water, D_2O) contained in a single liter of seawater, a power equivalent or greater than that produced by combustion of 300 liters of gasoline! That power is quite sufficient to desalinate the original liter of seawater and transfer it to any point on the Earth.

6) By developing intensive gardening within transparent enclosures, we can recycle transpired and evaporated water. By increasing the humidity in such controlled environments, the rate of water loss from plants and soil is greatly reduced, as demonstrated by various projects in Saudi Arabia. The same applies to special forms of irrigation (e.g., "drip" irrigation) and drainage systems developed for desert agriculture, as well as irrigation of salt-resistant plant varieties with water of lower quality. Similarly, recycling of water in industry can decrease the nominal consumption of fresh water by orders of magnitude (see Table 3). Generally speaking, such water-saving techniques accomplish an intensification of useful water throughputs, at the cost of higher energy inputs and other investments per unit area.

7) In the long term, by "greening the deserts" using large-scale irrigation, we accelerate the water throughput of the biosphere and influence the climate to the effect of increasing precipitation, eventually eliminating the deserts altogether.

8) Even if—as might actually be the case for the Moon—sufficient raw water did not exist on the Earth, we could in principle synthesize it, as necessary, through a combination of chemical and nuclear processes. This is not a realistic prospect at present, but will eventually become so in the future.

The question of cost

These points establish the fact that the provision of fresh water supplies is limited only by the development of productive power, through technology. Often however, this fact is obscured by misplaced emphasis on apparent monetary cost. There are two points to be made in this connection. The economic costs of water supplies are determined by two major factors: 1) the natural environment of the region (climate, geology, hydrology, ecology, etc.); 2) development of the productive powers of labor, as reflected in technology.

It is obvious that to provide a given flow of fresh water per square kilometer of a desert area, requires a relatively greater effort (other things being equal) than to provide the same flow density in an area with abundant rainfall or in the vicinity of a great river. This circumstance is reflected in the widely varying supply costs of fresh water in different areas of the United States, for example.

Apart from differences in natural environment, the cost of water is a function of the level of technology. Employing the full potentials of nuclear and other advanced technologies, the nations of North Africa and the Middle East might provide fresh water to their arid regions at a lower overall social cost, than the inhabitants of Central Europe expended for their water requirements three generations ago. We have only to compare the present projected costs of delivering nuclear-desalinated water to Middle Eastern deserts with effective cost (expressed in labor time) of fresh water supplies in Central Europe today and 75 years ago. The key to the matter is the dramatic increase in labor productivity over that period. That is the first point.

This being said, we must still assume a significantly higher cost of water than would prevail in less dry areas of the world *where the same technological level were employed.* So, the cost of nuclear-desalinated water pumped from sea level into the Arabian Desert, for example, would be about twice the present cost of municipal water supplied to the city of Munich. The cost of piping fresh water from Turkey are projected to be in the same range (Table 4). Given that nearly the entire water consumption for agriculture in Germany is provided "free" from rainfall, this high cost of water translates into a higher cost for domestically produced food, a higher cost of maintaining labor at any given living standard, and a higher relative cost for nearly every branch of production. This is particularly the case in an early phase of economic development, and raises an important point of economic policy.

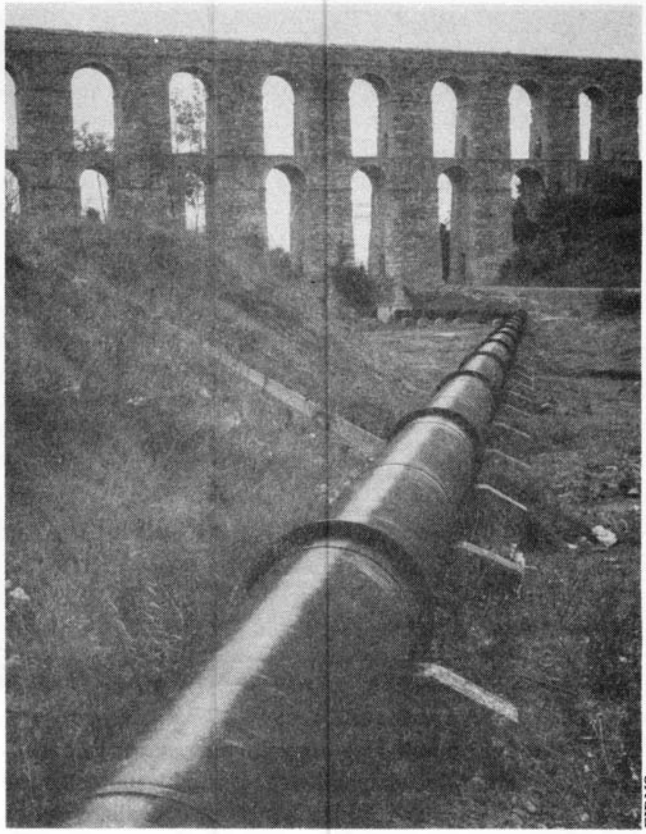
Should we then conclude, as economists of British "free market" persuasion do, that there is no point in developing agriculture and industry (apart from extraction and refining of oil) in the region, since these could not be competitive on the world market? Should we conclude, in particular, that the oil-producing nations of the region should restrict themselves to oil production, and import food and everything else from regions of the world where—owing to the lower cost of water—most production would appear to be cheaper? This would be to imitate the same arguments which the British used to discourage the industrialization of Germany during the first half of the 19th century! At that time, the relative underdevelopment of Germany's industry and infrastructure made the costs of domestic production appear astronomical compared to the prices the British Empire was offering for dumping its wares on the German market.

Parity and the development of labor power

Friedrich List's answer at that time, which Lyndon LaRouche has sharpened in crucial respects more recently, is essentially this: The goal and measure of economic activity is not to acquire various commodities at the lowest possible cost, nor to gain the largest margin of monetary profit. Rather, the purpose is to accomplish the *highest rate of growth in the productive powers of labor*. Wealth resides exclusively in the expansion of those powers.

So, by concentrating its efforts on developing science and technology, and a higher level of education of its labor force, Germany became the most powerful industrial nation in the world. Crucial to this was List's dual tactic of protective tariffs and development of infrastructure. The tariff system of the German Customs Union, or Deutsche Zollverein, ensured that none of a broad array of industrial commodities could be imported and sold at less than the cost of production of those same commodities in Germany, plus a certain margin which the fledgling German industry required for investment into technological improvements. The relative price level maintained in this way is known as a "parity price." (There are other means to achieve the same effect of parity, but the principle involved is always the same.)

Naturally, at first this meant paying a much higher price for various commodities than the "world market price" as determined, essentially, by the City of London. Within a short time, however, the construction of railroads and other infrastructure, together with development of technology, boosted the productivity of German industry to the point that the costs of production became generally much less than those in Britain—despite the British Empire's vast exploitation of slave labor and looting of raw materials!



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The pipeline bringing water from Istanbul's main reservoir to the water treatment plant. Behind it is a 12th-century aqueduct that was rebuilt in 1555. Turkey contracted a study to export by a "Peace Pipeline" about 3.5 billion m^3 of the daily "excess" water from the Seyhan and Ceyhan rivers to Syria, Jordan, and Saudi Arabia.

The same principles apply to developing the labor power of the Middle East and North Africa today. That is the second point. Were the equivalent of "parity prices" to be introduced in systematic fashion for a variety of agricultural and industrial products, combined with crash programs of water and other infrastructure development, we would see an unprecedented boom in the internal economies of the region—despite the relatively high apparent costs of water.

This brings up a deeper point concerning "cost."

We must consider, both on the local level of individual regions and nations, as well as on the level of the human race as a whole, how we can achieve the highest rate of development of the productive powers of labor. For, ultimately, in real economic terms, "cost" has only the significance of the difference in rate of development of the powers of labor resulting from alternative courses of policy. We "pay" for a wrong policy in a deficit of that development which would have occurred had we followed a more correct policy. Whereas, properly considered, we do not "pay" for a correct policy at all, but only gain from it.

Dependence on imports of consumer and other goods in exchange for oil, constitutes *zero development;* this is virtually the most "costly" of all policies for a nation, short of war. Furthermore, the lack of development of labor power in oil-producing countries, such as Kuwait, that have adopted such British-style policies, is a net loss to the world economy as a whole. This is true no matter what the price of oil on the world market. For, all labor invested in the production of commodities (e.g., those traded for oil) whose consumption is *not* associated with a process of development of labor power in the consumer, is *labor deprived of its potential for self-expansion—"dead" labor*. In addition, the toleration of such non-development must tend to draw the world into uncontrollable armed conflicts.

The essential precondition for development of labor power in the Mideast-North Africa region is essential infrastructure: above all, water supply and water management in conjunction with power generation and distribution, transport and communications. Investments in such infrastructure are by far the most profitable in real economic terms, of all investments in this region.

Actually, such a development program would give the nations of the region a unique advantage over other regions: The experience of intense problem-solving efforts using modern technology to "conquer the deserts," will transform the quality of culture and labor power in a manner which would hardly be possible without that challenge. It resembles in some respects the manner in which, in previous ages, nations were sometimes forged by the trials of war. This time the war is against the deserts, not men, and we gain the blessings of peace between nations and the future contributions of the millions of individual citizens of the Mideast-North African countries, to the progress of humanity as a whole.

U.S. Postal Service
STATEMENT OF OWNERSHIP, MANAGEMENT AND CIRCULATION
Required by 39 U.S.C. 3685

1A. *Title of Publication:* Executive Intelligence Review

1B. *Publication No.:* 02736314

2. *Date of Filing:* September 25, 1990

3. *Frequency of Issue:* Weekly except for the second week of July, the third week of August and the last week of December

3A. *No. of Issues Published Annually:* 50

3B. *Annual Subscription Price:* $396

4. *Complete Mailing Address of Known Office of Publication:* 1430 'K' St., NW, Suite 901; Washington D.C. 20005

5. *Complete Mailing Address of the Headquarters or General Business Offices of the Publisher:* P.O. Box 17390, Washington D.C. 20041-0390

6. *Full Names and Complete Addresses of Publisher, Editor, and Managing Editor*

Publisher: EIR News Service, Inc.; 1625 'I' St. NW #625; Washington, D.C. 20006

Editors: Nora Hamerman, P.O. Box 17390, Washington, D.C. 20041-0390

Managing Editor: John Sigerson and Susan Welsh, P.O. Box 17390, Washington, D.C. 20041-0390

7. *Owner:* New Solidarity International Press Service, c/o EIRNS P.O. Box 17390, Washington, D.C. 20041-0390; Nancy Spannaus, P.O. Box 17390, Washington, D.C. 20041-0390

Nora Hamerman, P.O. Box 17390, Washington, D.C. 20041-0390

8. *Known Bondholders, Mortgagees, and Other Security Holders Owning or Holding 1 Percent or More of Total Amount of Bonds, Mortgages or Other Securities:* None.

9. *For Completion by Nonprofit Organizations Authorized to Mail at Special Rates:* Not Applicable.

10. *Extent and Nature of Circulation*

	Average No. Copies Each Issue During Preceding 12 Months	Actual No. Copies of Single Issue Published Nearest to Filing Date
A. Total No. Copies Printed	13,121	14,800
B. Paid Circulation		
1. Sales Through Dealers and Carriers, Street Vendors and Counter Sales	3,458	3,150
2. Mail Subscriptions	7,647	9,074
C. Total Paid Circulation	11,131	12,224
D. Free Distribution by Mail, Carrier or Other Means, Samples, Complimentary, and Other Free Copies	1,045	1,086
E. Total Distribution	12,177	13,310
F. Copies Not Distributed		
1. Office Use, Left Over, Unaccounted, Spoiled After Printing	944	1,490
2. Return From News Agents	0	0
G. Total	13,121	14,800

11. I certify that the statements made by me above are correct and complete. NORA HAMERMAN, Editor.