EIR Economics

Vernadsky and the Biogeochemical Development of N. America's Desert

by Dennis Small and Richard Freeman

This study of a program for joint U.S.-Mexico development of the Great American Desert, is an expanded version of a presentation by EIR *Ibero-American Editor Dennis Small, at a LaRouche Youth Movement seminar in Mexico City on April 12. Research was contributed by Richard Freeman in Washington, and Ronald Moncayo in Mexico City.*

Nowhere is the bankruptcy of the free-trade economic model more evident, than in the U.S.-Mexico relationship. For two decades, Mexico has dutifully followed the International Monetary Fund's (IMF) prescriptions. And in the last decade, the North American Free Trade Accord (NAFTA) formalized and enthroned these same destructive policies as an international treaty among Mexico, the United States, and Canada.

The results are most visibly evident in Mexico's addiction to the economic cancer called *maquiladoras.* We are referring to the fact that the entire Mexican economy has been oriented to depend on exports to the United States, which are more than 90% of Mexico's total exports today; and that these exports come mainly from the *maquiladoras.* At this writing, the number of workers employed in *maquiladoras* is greater than those employed by all the rest of Mexico's manufacturing sector—although even *maquiladora* employment has been dropping.

The *maquiladoras* are not really part of the Mexican economy: They are cancerous foreign enclaves located on Mexican territory, using cheap Mexican labor, cheap Mexican power, and cheap Mexican *water* to export to the United States—in order to pay the country's foreign debt with the dollars that are earned. As for the United States, it has stopped producing what it needs, and its imports, its current account deficit, and its shocking debt are unsustainable. Its economy and financial system are disintegrating.

There is no question but that Mexico must *de-maquiladorize* its economy and its relationship with the United States. But, how to do that?—especially in light of the recent imperial war against Iraq, which rang in the new age of the Law of the Jungle in international politics. How to respond, given that we are at the end not only of the existing economic model, but of the political model as well?

That question is being posed today not only by Mexico, but by every nation of the Third World, and the developed countries as well.

To address it, we go back to statements made by Lyndon H. LaRouche during his visit to Saltillo, Mexico in November 2002. Asked how U.S.-Mexican relations could be reconstructed on a sane basis, LaRouche replied that Mexico and the United States, together, have to develop the Great American Desert (see Interview, page 26).

The Great American Desert covers a significant portion of northern Mexico and a large part of the U.S. Southwest. Its required joint development, LaRouche proposed, emphasizes three general areas of infrastructure: water projects; high-speed rail lines and other transportation systems; and power. All of this, he emphasized, has to be done from the methodological standpoint of Vladimir Vernadsky and his science of *biogeochemistry*, which posits the dominion of the Noösphere—that is, of the creative human mind—over both the living biosphere and the inert matter of the universe. Vernadsky also points us in the right direction for solving what is perhaps the oldest, and most elementary, question that arises when economic development is discussed: With so many urgent things to be done, with so many crying needs, with such poverty in the world, how do we decide what to do first? What is the trajectory to be followed? What is it that should be optimized? And how is it to be measured?

Also, how do you *de-maquiladorize* an economy? That has to be done, LaRouche answered, by taking advantage of

The California example of reclaiming and developing the Great American Desert is not to be attacked or undone, but to be re-enacted on a much grander scale, changing the face of the Great American Desert as a whole, by the United States and Mexico in cooperation.

the proximity of Mexico to the United States, a proximity which, to date, has been a large part of the problem that Mexico faces. Mexico needs *greater* integration with its neighbor to the north—but it has to be a different kind of integration than today's lunatic NAFTA. In terms of foreign policy, the United States must return to John Quincy Adams' approach: As Secretary of State at the beginning of the 19th Century, he proclaimed that the United States, as a sovereign nation, must foster the development of other sovereign nations to the south, and build relations with them based on mutually beneficial economic development—a community of interests.

Back in August 1982, LaRouche had reaffirmed this tradition in his famous *Operation Juárez* policy document, written after a May 1982 visit to Mexico which included a historic meeting with then President José López Portillo. In *Operation Juárez,* LaRouche called for the nations of Ibero-America to integrate, and collectively: a) demand a global reorganization of their foreign debt, and a new world monetary order; b) establish national banking systems, along the lines set forth by Alexander Hamilton in his American System of Political Economy; c) set up a common market and build great development projects across the region; and d) cooperate with the United States and other nations on these joint infrastructure projects, taking the approach of exchanging Ibero-American raw materials (such as oil) for advanced-sector technologies.

It is to this tradition—that of John Quincy Adams' approach, the tradition of LaRouche's Operation Juárez—that the region must now turn.

The Greening of the Deserts

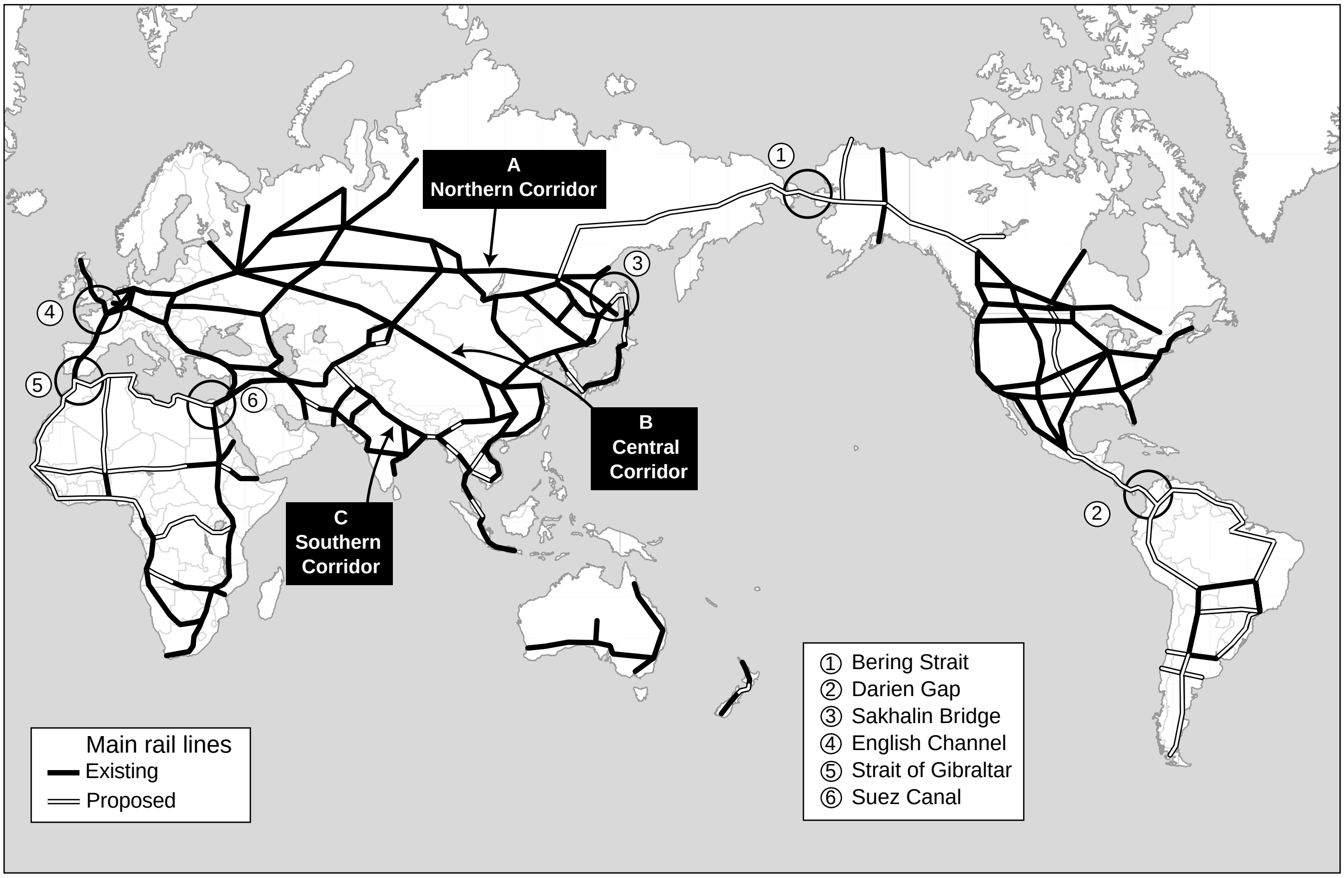
Let's begin with the World Land-Bridge (**Figure 1**). LaRouche has argued for the urgency of replacing the IMF financial system with a New Bretton Woods, and of building the great infrastructure project known as the Eurasian Land-Bridge as the motor for global economic development. In Figure 1, the solid lines represent existing rail lines: As can be seen, two of the three main routes of the Eurasian Land-Bridge are already a reality. There is the northern route, which cuts across Russia along the path of the old Trans-Siberian railroad, and links Vladivostock in the east to Rotterdam in the west. The second route, the central one, was completed in May 1996, and it crosses China and links it to Western Europe. The route which has not yet been completed is the southern one, which runs through Southeast Asia and India.

As can be seen on the world map, the priority trunk lines in Africa and Ibero-America have also not been built, nor have the two great projects which would link the Americas to the Eurasian Land-Bridge: the tunnel under the Bering Strait, and the railroad through the Darien Gap.

LaRouche has emphasized that these routes should not be simple rail lines, but rather 100 kilometer-wide development corridors designed to bring industrialization, advanced technologies, and city building to the most remote and underdeveloped interior of the continents.

There is nothing as underdeveloped as the desert and semi-desert areas of the globe, as can be seen in **Figure 2.** As a rule of thumb, a desert is an area where the mean annual

FIGURE 1
The World Land-Bridge



Source: *EIR.*

rainfall is 250 millimeters (10 inches) or less. Semi-desert or semi-arid areas are those receiving between 250 and 500 millimeters of rain per year. In Figure 2, the gray-shaded areas include both desert and semi-desert regions; that is to say, where mean annual rainfall is between 0 and 500 millimeters.

The world's principal deserts are located within these regions. It should be noted that, in addition to hot deserts, there are also cold deserts, where the little precipitation they have comes in the form of snow, not rain. The biggest desert on the planet, the Sahara desert, is a hot desert, and measures some 9.1 million square kilometers (roughly 3 million square miles). The second-largest (at 3.7 million square kilometers), is actually a series of cold deserts in China and Central Asia (such as the Gobi desert, the Takla Makan desert, etc.). The third-largest is the hot Arabian desert, tied with the Australian desert, at 2.3 million square kilometers.

The fifth-largest desert on the planet is the Great American Desert, which covers a good part of the north of Mexico, almost all of the U.S. Southwest, and stretches up into Canada. It has both hot and cold areas, and all in all, covers some 1.7 million square kilometers—almost a fifth the size of the Sahara.

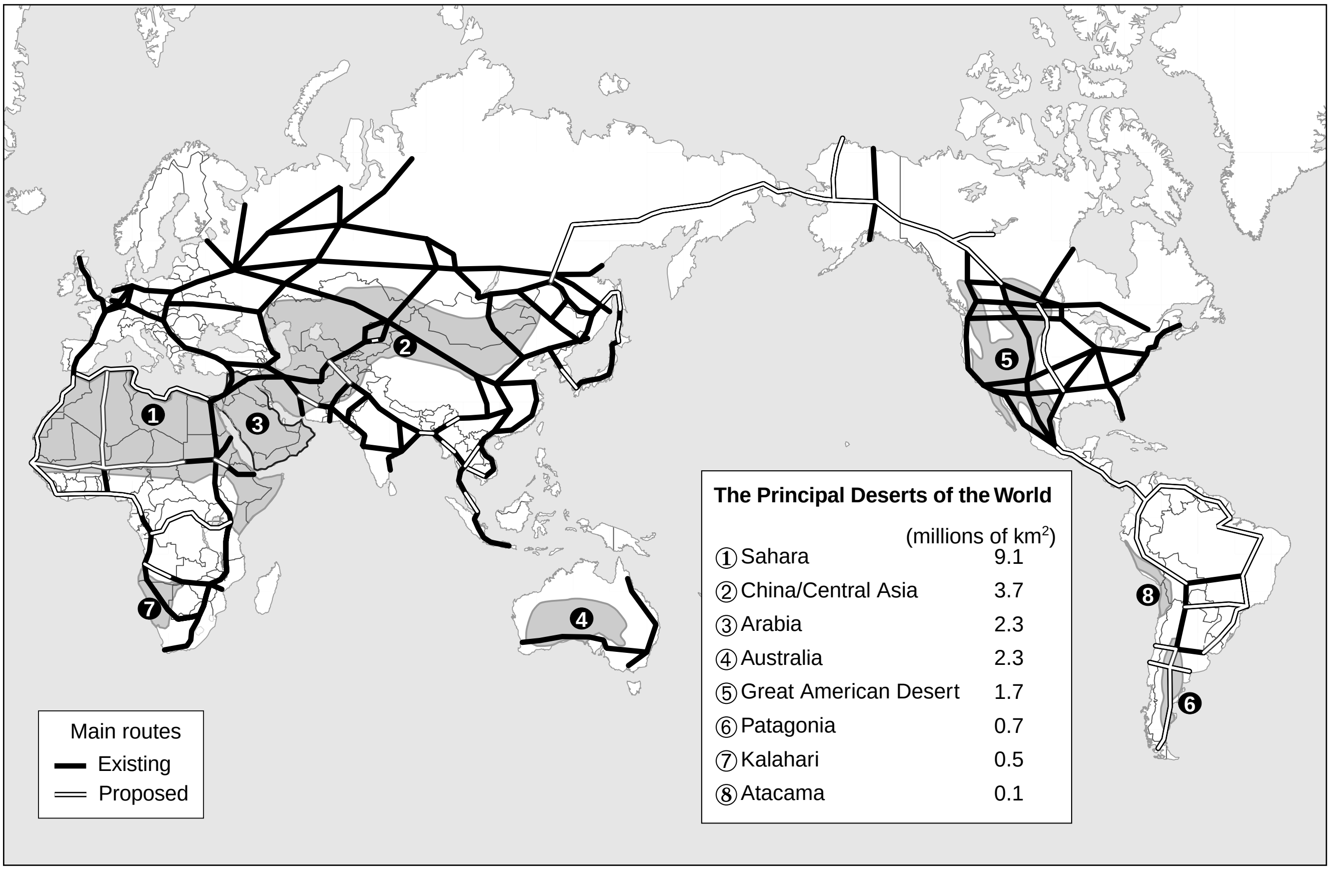
Now consider the relationship between these deserts and the development corridors of the World Land-Bridge. The first thing to emphasize is that, in posing the development of the deserts, we are proposing what is arguably the *most difficult* task of planetary development. It is much easier to develop areas that have a certain amount of water available—such as the Humid Pampa of Argentina, or Southeast Asia. Water is fundamental, not only for agriculture, but also for power generation and industry in general. **Table 2** gives you an idea of the amount of water required to produce some of the most basic necessities of modern daily life.

Is it not, perhaps, presumptuous on our part to propose to bring the level of development implied by these parameters to the deserts of the world? Would that not exhaust all the fresh water and other natural resources of the planet?

Not at all. In addition to transferring fresh water from one hydrological basin to another, wherever that is feasible and desirable, man is perfectly capable of *manufacturing* fresh water—by desalinating sea water. If we have enough power available—which means we have to seriously build nuclear

FIGURE 2

The World Land-Bridge and the Principal Deserts of the World*



The Principal Deserts of the World

	(millions of km²)
① Sahara	9.1
② China/Central Asia	3.7
③ Arabia	2.3
④ Australia	2.3
⑤ Great American Desert	1.7
⑥ Patagonia	0.7
⑦ Kalahari	0.5
⑧ Atacama	0.1

* Shaded areas include both deserts (0-250 mm. annual precipitation) and contiguous semi-arid area (250-500 mm. annual precipitation).

Source: *EIR*.

TABLE 2

Water Requirements for the Production of Various Goods

(Cubic Meters)

Item	Water
Eggs (1,000)	1,090
Wheat (1 ton)	1,365
Rice (1 ton)	4,945
Beef (1 ton)	24,400
Cotton (1 ton)	9,100
Cement (1 ton)	2.6
Electricity (1,000 KwH)	3.8
Automobile (1)	245

Source: "Water from Alaska," N.W. Snyder, Parsons Co. 1980.

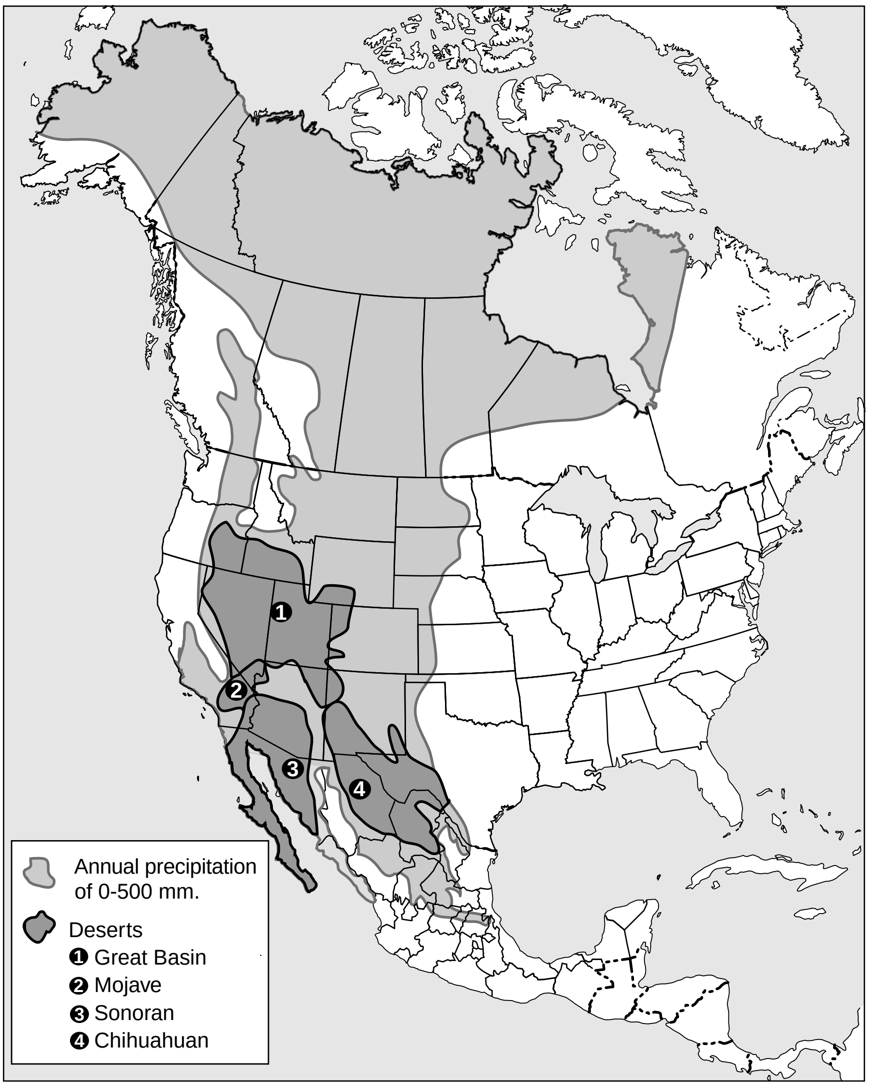
power plants—it is quite feasible and efficient, in physical-economic terms, to desalinate sea water.

And as an encouragement, we can look to the successful examples of the transformation of the desert. The Imperial Valley in California is perhaps the most famous case, as we shall explain below.

Returning to Figure 2, there is a second important feature that is immediately evident. Of all the World Land-Bridge routes which cut across the different deserts, only the North American one, the Great American Desert, spreads across an underdeveloped nation (Mexico) and a contiguous developed one (the United States). Would it not be interesting if we could solve the problem of development not only in a desert, but also in one where a paradigm change in North-South relations is required in order to succeed?

Thus, we are posing a difficult challenge, not only in economic terms, but politically as well. And if we are able to meet the challenge in this case, we will have met it, in principle, for the entire world. In other words: Globally, of necessity, we have to address two central problems at once: The free-trade model is disintegrating, and bringing the world economy down with it; and the political model of the existence of the sovereign nation-state is being threatened—which, with a modicum of international co-existence, has prevailed since the Peace of Westphalia of 1648.

FIGURE 3
The Great American Desert



Source: *EIR.*

The United States and Mexico have always been the decisive case, the litmus test, of North-South relations in general. If we cannot bring about what is necessary here, then it will not be achieved anywhere. And if we are successful in U.S.-Mexican relations, then there is hope for the entire world—even for tortured Africa, and its Sahara desert.

This is the significance of LaRouche's Great American Desert Development Project.

The Great American Desert

In **Figure 3,** we see the Great American Desert. Within this vast desert and semi-arid region, which receives 500 millimeters or less of annual precipitation, the four major deserts of North America are located:

1. The Great Basin: The largest in the continent, at 830,000 square kilometers, it is a cold desert located entirely within U.S. territory. It covers nearly the entirety of the states of Nevada and Utah, parts of Colorado, Arizona, and New Mexico; and it extends as far north as Oregon, Idaho, and Wyoming.

2. The Mojave Desert: Located primarily in California and southern Nevada, it is some 140,000 square kilometers in size, and is the driest and hottest place in the United States: California's famous Death Valley is in the Mojave.

3. The Sonoran Desert: Its 310,000 square kilometers are partly in the United States (Arizona and southern California) and partly in Mexico (Baja California Norte and Sur, and of course, Sonora).

4. The Chihuahuan Desert: This 445,000 square kilometer desert covers parts of the Mexican states of Chihuahua and Coahuila, and also parts of Texas and New Mexico in the United States.

Together, these four North American deserts add up to more than 1.7 million square kilometers of territory—nearly equal to the size of Mexico, which is 1.964 million square kilometers.

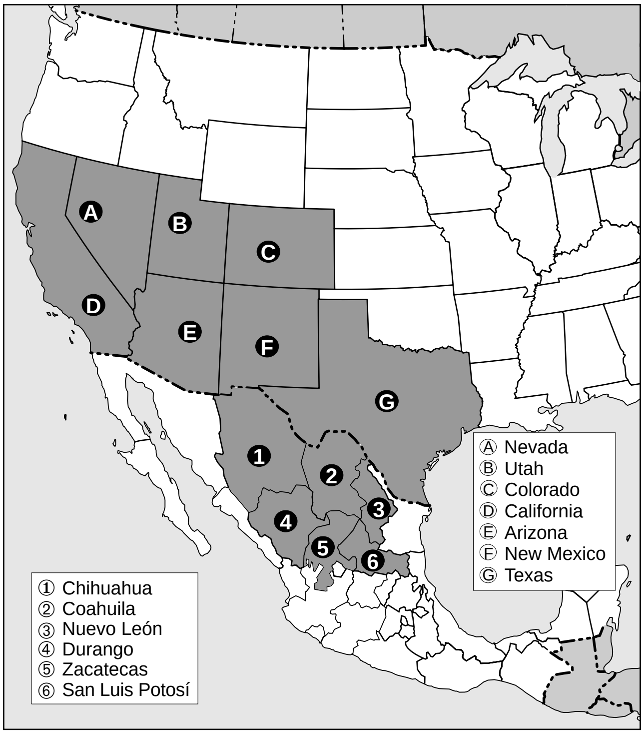
Within the broader Great American Desert region, we have selected six Mexican states and seven U.S. states for our programmatic focus (**Figure 4**): Chihuahua, Coahuila, Nuevo León, Durango, Zacatecas, and San Luis Potosí in Mexico; and Nevada, Utah, Colorado, California, Arizona, New Mexico, and Texas in the United States. Clearly, the hydrological zones of a country do not necessarily match the political divisions into states. But for purposes of calculation and presentation of the material, we are taking these 13 states as our "development zone," a zone sorely lacking in water, power, and transportation infrastructure.

In Mexico, these six are the northern states "embraced" by the two great mountain ranges, the Western Sierra Madre and the Eastern Sierra Madre (see **Figure 5**). This region is desert and semi-desert highlands. Meanwhile, most of Mexico's water is concentrated along the coasts, especially in the south of the country in the Isthmus of Tehuantepec, along the Gulf coast.

In relative terms, these six states have no water, no railroads, no power, and no population to speak of. It is a truly abandoned region. It constitutes 37% of the national territory

FIGURE 4

The U.S. and Mexico Development Zone



Source: *EIR.*

TABLE 3

Mexico: Population Density, 2002

State	Population (Millions)	Area (Thousands square kilometers)	Population Density (per square kilometer)
Chihuahua	3.1	247	13
Coahuila	2.4	153	16
Nuevo León	1.5	122	13
Durango	3.9	64	61
Zacatecas	2.5	61	40
San Luis Potosí	1.5	75	20
6 States Sub-total	**14.9**	**722**	**21**
Mexico	**101.0**	**1,964**	**51**
6 States as % of Mexico	37%	15%	40%

Source: INEGI (Mexico).

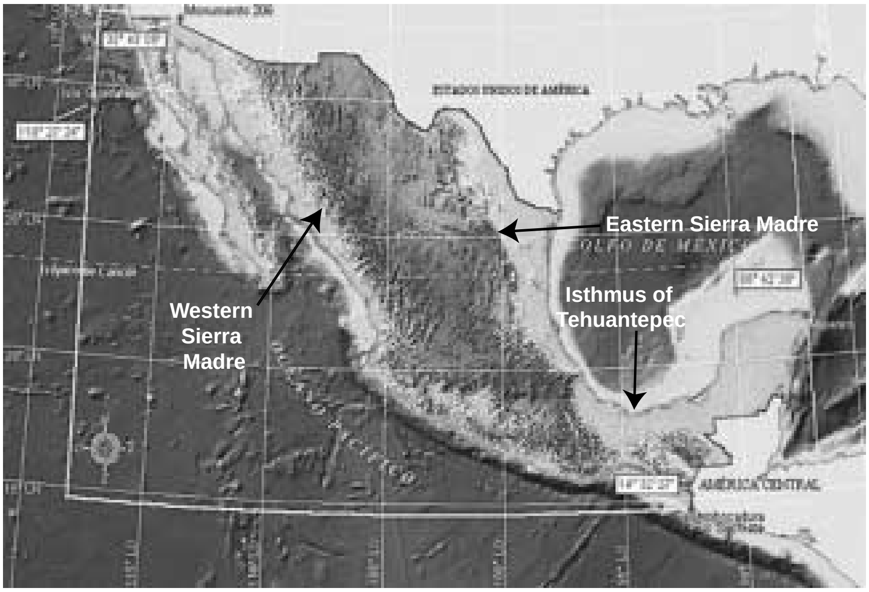
of Mexico, but 15% of the total population resides there. Its population density, therefore, is 21 inhabitants per square kilometer, as compared to the national average of 51 (see **Table 3**).

There is also not much industry. One could say that the predominant economic activity in the region is in the *maquiladoras,* the cheap-labor, in-bond assembly plants mainly along the border with the United States. Chihuahua, for example, is the number-one Mexican state in terms of employment in *maquiladoras:* It has 263,000 workers in the sector (24% of total national *maquiladora* employment), which is about 25% of the state's entire Economically Active Population (EAP). Coahuila is the third state in terms of employment in *maquiladoras* (with 116,000, or 11% of the national total); here, this is approximately 15% of the state's EAP.

This aberrant phenomenon of *maquiladoras* in the middle of the desert—a desert both in the literal sense, as well as in terms of lack of infrastructure and productive economic activity—is closely linked to the problem of migration, which has so dominated U.S.-Mexican relations of late. It is estimated that there are some 9 million Mexicans living in the United States—some legal, others illegal. This is almost 10% of Mexico's population of 101 million. In 2002, these emigrants sent some $9.8 billion in remittances back to Mexico, more than the $8.9 billion brought in by tourism that same year. The only line of the Mexican current account which

FIGURE 5

Mexico: Principal Mountain Ranges



Source: INEGI (Mexico).

FIGURE 6

Mexico: Population, Emigration and Development

Source: INEGI (Mexico); EIR.

exceeds this, are oil exports, with $14.5 billion in 2002.

Figure 6 points to a very significant geographic and economic relationship. Half of the Mexican population, some 50 million people, is concentrated in a belt of seven "federation entities" (states and the national capital) in the center of the country: Jalisco, Michoacán, Guanajuato, Mexico State, Mexico City, Puebla, and Veracruz. The main "federation entities which expel international migrants"—the terminology of the official National Institute of Statistics, Geography and Information (INEGI)—coincide, to a large degree, with that demographic belt: The six states marked in gray on the map have been the home states of more than half of Mexico's total emigrants, the vast majority of whom go to the United States. Our projected "Northern Development Zone" only retains a small percentage of those migrants—and these in the concentration camps known as *maquiladoras.* That is, *there is nothing, no productive economic activity, to keep them in Mexico.*

However, by turning them into a true development zone with great infrastructure projects such as those we propose below, these six states could provide productive employment not only to their own inhabitants, but to millions of other Mexicans who today end up either in the *maquiladoras,* or across the border, or suffering unemployment and hunger in their home states.

In the United States, there are also conditions of relative underdevelopment in the states of Nevada, Utah, Colorado, Arizona, and New Mexico. California and Texas have had relatively greater development, but we include them in this study for reasons we detail below.

Approximately 85% of the expanse of the seven U.S. states under consideration is covered by the Great American Desert, and is broadly underpopulated and undeveloped. On the whole, it has little manufacturing or industry; a rail system that is collapsing; limited water supplies that are being drawn down at a growing rate; and grossly inadequate energy supplies. To blame is the oligarchical policy of enforced underdevelopment, which President Teddy Roosevelt first imposed during the period 1901-09. This policy blocked a vital array of infrastructure, and has been adhered to throughout most of the past 100 years, with a few notable exceptions.

California and the eastern half of Texas have undergone some development, and were exceptions to this state of affairs; but, over the last few decades, they too have become afflicted by many of the region's problems.

Table 4 shows the region's underpopulation. In the year 2000, the seven-state region had a population of 70.2 million, which represented 25% of the United States' population; and a total area of 2.49 million square kilometers (about 800,000 square miles), which represents 26% of the nation's total. Thus, the average population density of the seven-state region is virtually the same as the national average of 29 people per square kilometer.

But note that almost 55 million people (more than three-quarters) of the population of the seven states reside in just two, California and Texas. In fact, Texas is better conceived of as two states in one: eastern and south central Texas, which includes Dallas, Houston, and San Antonio, which has a significant population and industrial activity; and the vast area of the western half of Texas, which has very little population and is underdeveloped.

To appreciate the underpopulation of the seven states, compare their population density to that of Ohio, an industrialized state which also has a decent-sized agricultural sector. Ohio has a population density of 98 people per square kilometer. As Table 4 shows, New Mexico has only 6% of the population density of Ohio; Nevada, only 7%; and even Texas, only 31%.

TABLE 4

U.S.: Population Density, 2000

State	Population (Millions)	Area (Thousands square kilometers)	Population Density (per square kilometer)	% of Ohio's Population Density
Nevada	2.0	286	7	7%
Utah	2.2	220	10	10%
Colorado	4.3	270	16	16%
California	33.4	411	82	84%
Arizona	5.1	295	17	17%
New Mexico	1.8	315	6	6%
Texas	20.9	692	30	31%
7 States Sub-total	**70.2**	**2,490**	**28**	**29%**
Ohio	11.4	116	98	—
United States	**281.4**	**9,629**	**29**	**—**
7 States as % of U.S.	25%	26%	97%	—

Source: U.S. Department of Commerce; *EIR.*

TABLE 5

U.S.: Total Workforce and Manufacturing Workers, October 2002

(Thousands of Workers)

State	Total Non-Farm Workforce	Manufacturing	Mfg. as % of Total
Nevada	1,077	46	4.3%
Utah	1,063	120	11.3%
Colorado	2,186	183	8.4%
California	14,665	1,795	12.2%
Arizona	2,252	193	8.6%
New Mexico	764	39	5.1%
Texas	9,415	996	10.6%
7 States Sub-total	**31,422**	**3,372**	**10.7%**
United States	**130,915**	**16,596**	**12.7%**

Sources: U.S. Department of Labor, Bureau of Labor Statistics; *EIR.*

Table 5 shows the seven-state region's underdeveloped labor force, especially in manufacturing; again, skewed toward California and Texas. Of the region's 31.4 million nonfarm payroll workers, and 3.4 million manufacturing workers, a staggering 77% and 83%, respectively, work in California and Texas (mostly Texas' eastern portion). The other states have a manufacturing workforce which, on average, is only 8% of their total workforce—that is, manufacturing hardly exists, and urgently needs to be built up. For the United States as a whole, the manufacturing workforce constituted only 12.7% of the total non-farm payroll workforce, down from 22.4% in 1980, as de-industrialization has taken its toll.

The Franklin Roosevelt Example

We have chosen what is clearly the most abandoned binational zone, essentially for the same reason that U.S. President Franklin Delano Roosevelt launched the Tennessee Valley Authority (TVA) program back in 1933. At that time, that region was pretty much the most backward in the country, with extreme poverty, especially in Appalachia. Roosevelt wanted to prove that, with a government-led mobilization of national resources and capabilities, the United States could beat the Great Depression and solve the most difficult problems of development.

Toward that end, he launched what he called his "Four Quarters" plan, to develop the four corners of the country with great infrastructure projects (**Figure 7**). What was done in the Southwest is of particular relevance to the issue at hand. They tamed the Colorado River, which previously had caused terrible losses during periods of flooding, by constructing a series of hydro-electric dams along its length, which not only supplied water to parched regions, but also significant amounts of electricity. The most important of these was the Hoover Dam, completed in 1935, and at its time, the largest dam on the face of the Earth. With the Hoover Dam, the United States was able to open up all of southern California to agriculture—including the famous Imperial Valley—thanks to the large amounts of water transferred by the All-American Canal.

What was the Imperial Valley before the construction of these projects? It was a desert; part of the Great American Desert. And how was this done? With water, vast quantities of water supplied economically and reliably, thanks to government regulation. It is a good example of what is feasible, with combined development between Mexico and the United States.

Figure 8 shows the average annual rainfall in northern Mexico. (We have used official data from INEGI, which uses parameters of 0-300 mm and 300-600 mm of rainfall—similar but not identical to the 0-250 mm and 250-500 mm standard used in the rest of this study. The relationship of these zones to the six states of our study is also shown.)

Table 6 shows the mean annual rainfall in various states of Mexico, according to their rank out of 32 "federation entities" (the national average is 772 mm per year). The two rainiest states are Tabasco, with 2,413 mm, and Chiapas, with 1,961 mm, both located on the Isthmus of Tehuantepec, which is also where the two rivers (the Grijalva and the Usumacinta) with the greatest run-off are located.

The most arid states are Baja California Sur and Baja California Norte. The six states which make up our "Northern Development Zone" are also among the most arid in the country—they are in the lowest third in national ranking. The sole exception is San Luis Potosí, because the eastern portion of that state is on the lowlands side of the Eastern Sierra Madre, in a tropical region where there is a great deal of rain.

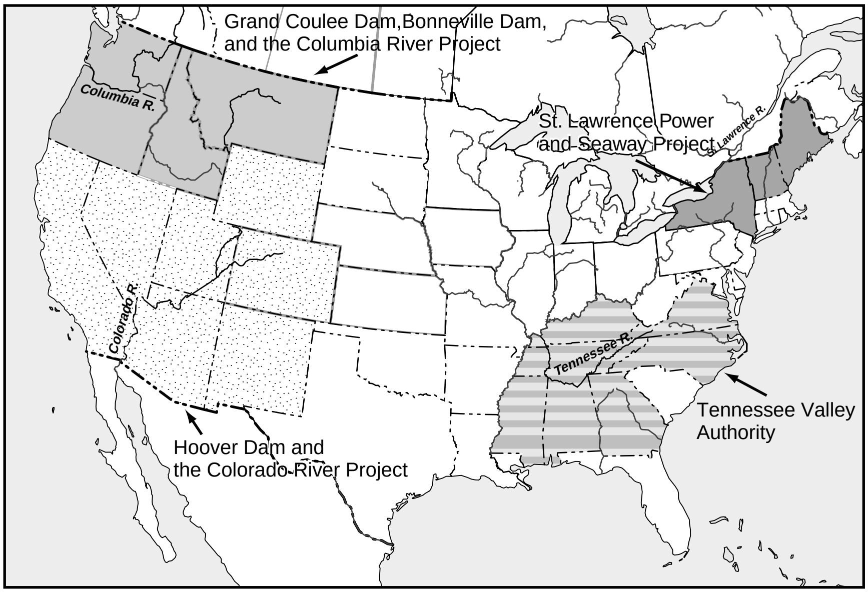
As for the U.S. side, the seven-state region, though it has a low level of annual rainfall, accounts for a sizeable amount of the nation's freshwater withdrawals. Such withdrawals come from two sources: surface (rivers and lakes) and ground (mainly aquifers). In 1995 (the last year for which data exists), this region withdrew 126 billion cubic meters (33.3 trillion gallons) of fresh water annually, which constituted almost 27% of the national total of freshwater withdrawals. Of that amount, a staggering 71% was employed in irrigation—far higher than the national average of 42%. The other three major uses of fresh water in this region, were for public supply (13% of total); thermo-electric cooling of power plants (11% of total); and industry proper (2% of total).

However, per-capita water withdrawal in this region has been falling steeply, even more rapidly than the national average (see **Figure 9**). Taking withdrawals of both fresh water and saline water combined, in 1970, in the seven-state region, the water withdrawn was 10.6 cubic meters (2,800 gallons) per person, per day; by 1995, it had dropped to 6.3 cubic meters (1,670 gallons)—a 41% collapse over 25 years. This desperately arid region now withdraws about the same amount of water per capita as the national average.

How can this region survive with less water? The per-capita fall, both in this region and nationally, represents in part some increased efficiency in water use, through drip irrigation in agriculture, and some more efficient uses in industry. However, it fundamentally reflects a drop in the water throughput needed to sustain human existence in a modern economy. This has included the shutting down of factories. But over the past two decades, the United States has also increasingly outsourced the production of goods and foods to other

FIGURE 7

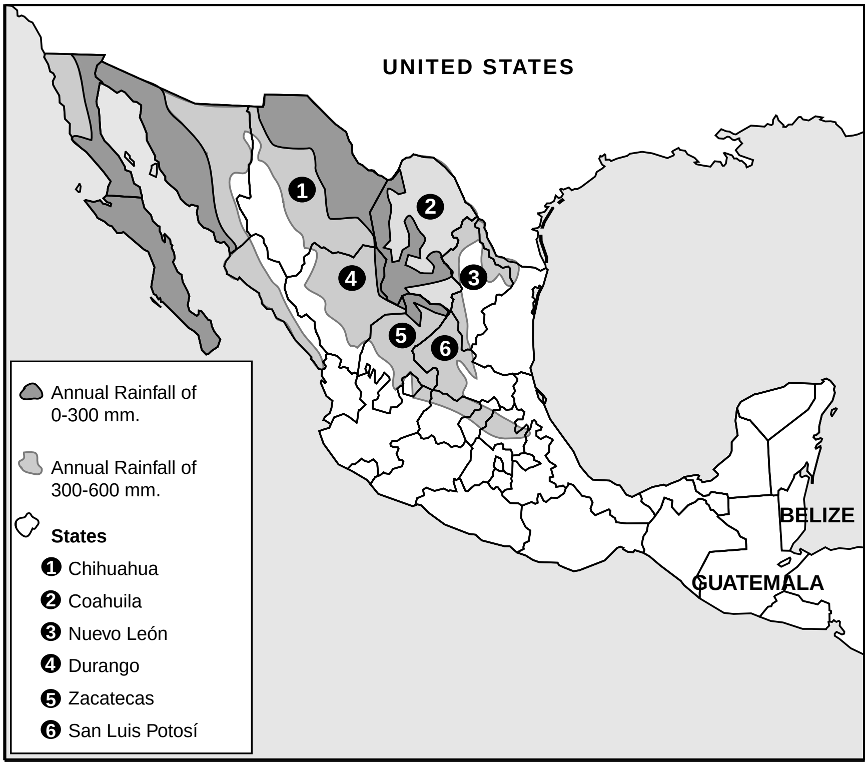
Roosevelt's 'Four Quarters' Development Projects



Source: *EIRNS.*

FIGURE 8

Mexico: Annual Rainfall and Principal Deserts



Sources: INEGI (Mexico): *EIR.*

TABLE 6

Mexico: Mean Annual Rainfall

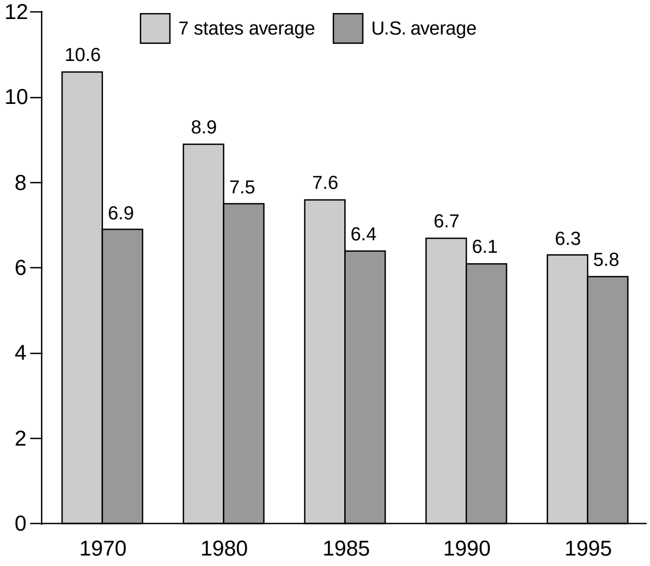
Rank	State	Rainfall (Millimeters)
1	Tabasco	2,413
2	Chiapas	1,961
11	San Luis Potosí	960
22	Nuevo León	589
25	Zacatecas	516
26	Durango	509
29	Chihuahua	423
30	Coahuila	316
31	Baja California Norte	203
32	Baja California Sur	176
—	**National average**	**772**

Source: INEGI (Mexico).

FIGURE 9

U.S.: Per Capita Water Withdrawals

(Cubic Meters per Day)



Sources: U.S. Geological Survey; U.S. Statistical Abstract (various years); U.S. Department of Commerce; *EIR.*

TABLE 7

Annual Water Withdrawal

	Mexico	Spain	U.S.	Mexico as % of U.S.
Total (Cubic km)	72	33	469	15%
Per Capita (Cubic Meters)	715	837	1,688	42%
Per Square Kilometer (Cubic Meters)	37,000	66,000	49,000	76%

Sources: FAO; U.S. Geological Survey.

countries, especially Mexico under NAFTA. When Mexico produces most or all of the parts of a car (which requires about 245 cubic meters, or 65,000 gallons, of water to produce), and ships tomatoes, broccoli, and so on to the United States, then the water requirements for producing these goods are borne by Mexico.

The physical economic cost of that *maquiladora* and related activity has by no means been covered: that would require significant investments in infrastructure for water, industry, and agriculture in Mexico, which have of course not occurred. So the *maquiladora*/NAFTA regimen has meant the physical-economic looting of Mexico's water resources, as well as its cheap labor. In fact, the entire international hullabaloo led by the U.S. State Department about how Mexico supposedly "owes" the United States fresh water from the shared Rio Grande, only shows the insanity of this accountant's view of economics: The physical economic reality is exactly contrary.

Yet, even the reduced rates of water used in the United States exceed the currently available sources—as they do in Mexico. In other words, the U.S. physical economy is *also* being looted by lack of investment in water infrastructure. In the 1997 book, *Pillar of Sand,* author Sandra Postel reported: "California is overdrafting groundwater at a rate of 1.6 billion cubic meters a year, equal to 15% of the state's annual net groundwater use. Two thirds of this depletion occurs in the Central Valley, which supplies about half of the nation's fruits and vegetables." In 1996, *EIR*'s Marcia Merry Baker reported that California obtains 40% of its annual water from pumping groundwater, and that 11 of the state's 50 major aquifers were in overdraft.

Roosevelt's great Hoover Dam provides huge quantities of water from the once untamed Colorado River to many of the seven states under consideration, including a considerable amount of fresh water for the city of Los Angeles. But the project is nearly 70 years old, and the water level of the Colorado River is now so oversubscribed, that there are near-shooting wars between Arizona and California over the use of the water.

1 Cubic Meter Does Not Equal 1 Cubic Meter

Table 7 presents comparative data regarding water withdrawals. In the case of Mexico, some 72 cubic kilometers of water are withdrawn per year (1 cubic kilometer = 1 billion cubic meters = .81 million acre-feet = 264.2 billion gallons). In Spain, it is 33; and in the United States, 469. If we look at the ratio between Mexico and the United States, we find that

Mexico withdraws 15% as much water as the United States—which should not surprise us, given Mexico's relative underdevelopment compared to the United States.

Now let's look at the amount of water available per capita, which is calculated by dividing the total withdrawals by the total population. Mexico has 715 cubic meters per capita; Spain, 837; and the United States, 1,688. In other words, per capita, Mexico has 42% of what the United States has available. This ratio should begin to awaken our curiosity, because it is telling us that every Mexican has available to him nearly half the water that each American has. One would have assumed that Mexico, given its relative underdevelopment, would have had much less than that available.

But now let's use a third ratio as a metric for our comparisons: water withdrawals per square kilometer of national territory. Mexico has 37,000 cubic meters of water per square kilometer of territory; Spain has 66,000; and the U.S. has 49,000. Here the ratio between Mexico and the United States is a hefty 76%. That is, your average square kilometer of Mexican territory has more than three-quarters as much water available to it, as the average square kilometer in the United States.

At this point, our curiosity is turning into surprise. How is it possible that Mexico, with its known shortage of water in a large part of its national territory, has nearly as much water available per square kilometer as does the United States? Could it be that there isn't the kind of strong relationship between water and economic development, that we posited at the outset? Or is it, perhaps, that a cubic meter of water in Mexico *is not equal* to a cubic meter of water in the United States in physical-economic terms?

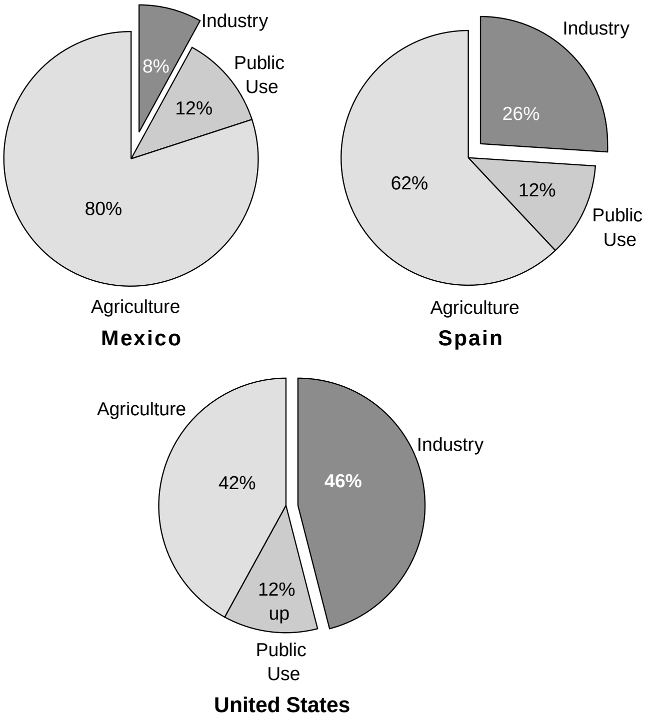
To go from curiosity, to surprise, to the solution to this paradox, let's look at another facet of the matter: the water's *use.* As can be seen in **Figure 10,** Mexico's agricultural sector uses 80% of the total water withdrawn; in Spain, it is 62%; in the United States, 42%. The public use of water is the same in the three countries, at 12%. But the big difference jumps out at you when you look at industrial use: 8% in Mexico, 26% in Spain, and 46% in the United States. This suggests that the physical-economic value of water is not a scalar quantity (we have already shown that 1 cubic meter does not equal 1 cubic meter the world around), but that it depends, among other things, on the *use* to which it is put. In addition to that, it should be noted that in Mexico, only 30% of all arable land is irrigated, or some 6.3 million hectares. And of those irrigated hectares, only 700,000—that is, 11% of the total irrigated—are also mechanized and have other technological inputs (fertilizer, pesticides, etc.).

In other words, *there is water* in Mexico—at least in relative terms and as a national average. But water is not water; 1 cubic meter of water doesn't equal 1 cubic meter of water. It depends on the *form of organization* of that water; that is, on the general technological level of the economy which shapes the way a cubic meter of water is utilized.

FIGURE 10

Water Use

(Percent of Total)



Sources: FAO; U.S. Geological Survey.

In a sense, that is obvious. But it also poses something fundamental regarding the problem of measurement in an economy. You cannot measure in *fixed* units, be they monetary or physical; because the metric changes, depending on the physical-economic composition, and especially the technological composition, of the economy as a whole.

LaRouche has discussed the related matter of energy. For starters, *energy* is not the correct word, because in its modern acceptance, it communicates a scalar, or algebraic concept. It were better to speak of *power,* a concept which comes from Platonic physics. LaRouche has emphasized the significance of *energy flux density* in a process: that the efficiency in the use of a BTU or a KwH of energy, depends on how concentrated that use is. For example, a laser is more efficient than a thousand flashlights, or a million candles, although they may have the same scalar energy value.

Thus, we should perhaps also speak of *water flux density* and not simply cubic meters of water.

And so, before presenting our programmatic solution to the crisis that Mexico and the United States are facing, we must first turn to the concept of the Noösphere developed by Vladimir Vernadsky—even if only to learn how to measure in an economy.

The Contribution of Vernadsky

Vladimir Vernadsky was born in 1863 and died in 1945. He was a student of the great Russian scientist Dmitri Mendeleyev, and came out of the classical Russian tradition linked to the Western European scientific tradition of Gottfried Wilhelm Leibniz. Vernadsky was one of the founding fathers of the Soviet nuclear program, as well as the founder of a branch of physical science which he dubbed *biogeochemistry.*

Let us look at a study which Vernadsky wrote called *Problems of Biogeochemistry II: On the Fundamental Material-Energetic Distinction Between Living and Non-living Natural Bodies of the Biosphere* (*21st Century Science and Technology,* Winter 2000-2001). In this essay, Vernadsky presented his concept of the Noösphere.

He began by asserting that there is a fundamental material-energetic difference between, on the one hand, non-living matter—abiotic or inert matter, such as cement, plastic, iron, and so forth—and living matter, the Biosphere, on the the other. He then went on to explain that there is also a fundamental difference between that Biosphere and the Noösphere, that is, between simply living matter, on the one hand, and *conscious* living matter, on the other. This is how he put it: "We are living in a brand new, bright geological epoch. Man, through his labor—and his conscious relationship to life—is transforming the envelope of the Earth—the geological region of life, the *Biosphere.* Man is shifting it into a new geological state: Through his labor and his consciousness, the Biosphere is in a process of transition to the *Noösphere.* Man is creating new biogeochemical processes, which never existed before. The biogeochemical history of the chemical elements—a planetary phenomenon—is drastically changing. Enormous masses of new, free metals and their alloys are being created on Earth, for example, ones which never existed here before. . . .

"In this geological process—which is fundamentally biogeochemical—a single individual unit of living matter, out of the totality of humanity—a great personality, whether a scientist, an inventor, or a statesman—can be of fundamental, decisive, directing importance, and can manifest himself as a *geological force.*"

(I must admit, parenthetically, that we have invited all of you to this seminar and other similar ones, for precisely that: to encourage you to join the LaRouche Youth Movement, so that each and every one of you can become a *geological* force to change the universe.)

So, Vernadsky stated that there are these three, distinct forms or phases of existence in the physical universe: 1) the abiotic or inert, the nonliving; 2) the biotic, which is living; and 3) that of conscious life, the human mind. But he also insisted that there is a continuous, and clearly causal connection among these three geometries of existence, despite the fact that there are unbridgeable differences among them, differences which make it impossible to use the same metric in each of them. Thus, the question arises: How is it possible to have a process with geometric phase-changes which makes each phase incommensurable with the others; but, a process in which, all the same, these phases co-exist and furthermore have a causal effect upon each other?

Vernadsky tackled the problem by first reasserting that there is an "acute, unbridgeable distinction between living natural bodies and inert natural bodies in the biosphere," and stating that the first task is to identify and catalogue these essential distinctions. We will here mention four of the most critical ones.

The *first difference* is: "The direct generation of a living organism from inert bodies is never observed."

This is a simple statement of fact, but it has major implications for epistemology and our understanding of evolution. (It's hardly necessary to say that the inverse process is observed every day of the week—in the generation of inert bodies from living organisms—such as occurs constantly in university classrooms in the United States and Mexico.) Vernadsky, with this simple, documented, empirical observation, has demolished the central argument of the proponents of what we might call "the universal theory of flukes," to wit: the assertion that the universe is one, big game of chance, of flukes; that life evolved from non-life due to random events; and that conscious life similarly appeared as a pure fluke.

In all essentials, these arguments are the same as the theory of Darwin—a hard-core Aristotelean. It is also the essence of existentialism, and of British positivism and other variants of empiricism, all of which deny the existence of creativity. They insist that the human mind is nothing but a powerful computer, and that the only thing which we know is what our senses perceive, along with the combinations of those perceptions which our mental computer carries out. From there, it is just a short logical step to say that the human mind boils down to a complex network of chemical reactions responding to perception, and that all of the great discoveries and works of art are thus biochemical flukes.

According to this classically Aristotelean world-view, if you put a million chimpanzees in a big room, and you gave them all computers so that they could write, and if you gave them an infinite amount of time, sooner or later the chimpanzees would write all the great works of Classical literature. They might take a long, long time to do it, our obstinate Aristotelean concedes, but—sooner or later—one of those chimpanzees would come up with a fluke.

You can just imagine the laboratory of such madmen. There are the "scientists," cataloging what the chimps are up to; and one of them gets all excited and hollers to his colleague: "Hey Frank, come here! I think we've finally got it! Read what this chimp is writing: 'To be, or not to be, that is the mixzllsdvipad'. . . . Damn, what a shame! He'd almost written Shakespeare's *Hamlet.* Oh, well, we'll have to wait another million years, to see if he writes the rest."

But let's return to Vernadsky. He said that the *second difference* of note is that living matter, unlike non-living matter, creates free energy through work. Inert matter is entropic; that is, the energy of the system of non-living matter tends to dissipate. But when you consider living matter, he explains, "each organism is a source of *free energy in the Biosphere*—free biochemical energy."

The *third difference* that Vernadsky observed and catalogued is even more fundamental: that space itself is not identical in the two cases: "The scientific hypothesis of a special geometrical structure of space for bodies of living matter is admissible, and requires verification—a space not corresponding to Euclidean geometry."

That is, Vernadsky is telling us that Euclidean geometry may work for non-living matter. But when you look at living matter, space and also time are different: "It is convenient for purposes of organizing scientific work, to take as a scientific working hypothesis, that the space inside a living organism is different from the space inside inert natural bodies of the Biosphere; that this space does not correspond to a special state of living matter within the bounds of Euclidean geometry, and that time is expressed in this space by a polar vector. The existence of right- and left-handedness, and their physico-chemical non-equivalence, point to a different geometry than Euclidean—the geometry of space inside living matter."

Vernadsky was here asserting what Leibniz and Bernhard Riemann had also posited, in their own way, centuries earlier: that space and time are *not* parameters which are independent or exogenous to the process under study. It is not valid to assume that the universe as a whole functions in Cartesian space, which extends in infinite scalar form in three dimensions, and that time is also scalar and runs infinitely in one direction. Leibniz, Riemann, and Vernadsky all say that, on the contrary, physical space-time has *curvature;* that that curvature changes as a result of the lawful process of development of the universe itself; and that, therefore, there is no fixed metric which can be imposed from the outside. The metric of a process depends on the characteristic features of that process, and it *changes.* Or, in Leibniz's words, there is no valid metric independent of position. This, Leibniz often referred to as *analysis situs.*

The *fourth difference,* Vernadsky wrote, has to do with time: Time in the world of the inert is not the same as in the world of the living. "All physico-chemical processes in inert natural bodies are reversible in time. The space, in which they occur—the space of Euclidean geometry—is in an isotropic or anisotropic crystalline state. The physico-chemical processes, which create living natural bodies in the Biosphere, are irreversible in time. It is possible, that this will turn out to be a consequence of a special state of space-time, having a substrate that corresponds to a non-Euclidean geometry."

Thus far, Vernadsky had argued that the universe as a whole is not Euclidean; but he had also posited that it is a process which generates changes of curvature; that is, that the physical universe is in a constant process of change, of constant creation, that it is not a fixed universe. This universe evolves; that is, it has states or phases which are lower and higher, with their respective curvatures. This is what Riemann, in the middle of the 19th Century, referred to as a nested series of "manifolds," with their respective laws and curvatures; the real process of development of the universe carries us from one manifold to the next, in an ordered way.

How to measure in a universe whose characteristic is that of a nested series of ordered manifolds? This took Vernadsky to the richest part of his essay, the Noösphere.

Vernadsky asserted that, with the introduction of mind, of human labor, another qualitative leap occurs: The Noösphere emerges and begins to exert dominion over the Biosphere. Ideas themselves become a geological force, a material force of enormous power.

LaRouche has often emphasized that ideas have no weight, no size, no smell—they are imperceptible to the sensory apparatus. They would appear to have no physical existence. Nonetheless, they are the most powerful physical force in nature. Vernadsky, from his vantage point, took note of "the enormous new form of biogeochemical energy, constituted in the Biosphere by the technical *work process of the human race,* which is directed in a complex manner by human thought—consciousness."

And he said, that with the appearance of this new factor, the biogeochemical process of change is vastly accelerated. "In the course of geological time, new inert bodies emerged only under the influence of the evolutionary process of living matter. The creation of such new inert bodies is occurring in a drastic and powerful way—and their significance is growing—in the Noösphere of the present epoch, as a consequence of human creativity."

Four hundred years before Vernadsky, the great German philosopher and scientist, Cardinal Nicolaus of Cusa, had set forth his own epistemological conclusion in light of the same evidence, with the simple phrase: "Mind is the metric of the universe."

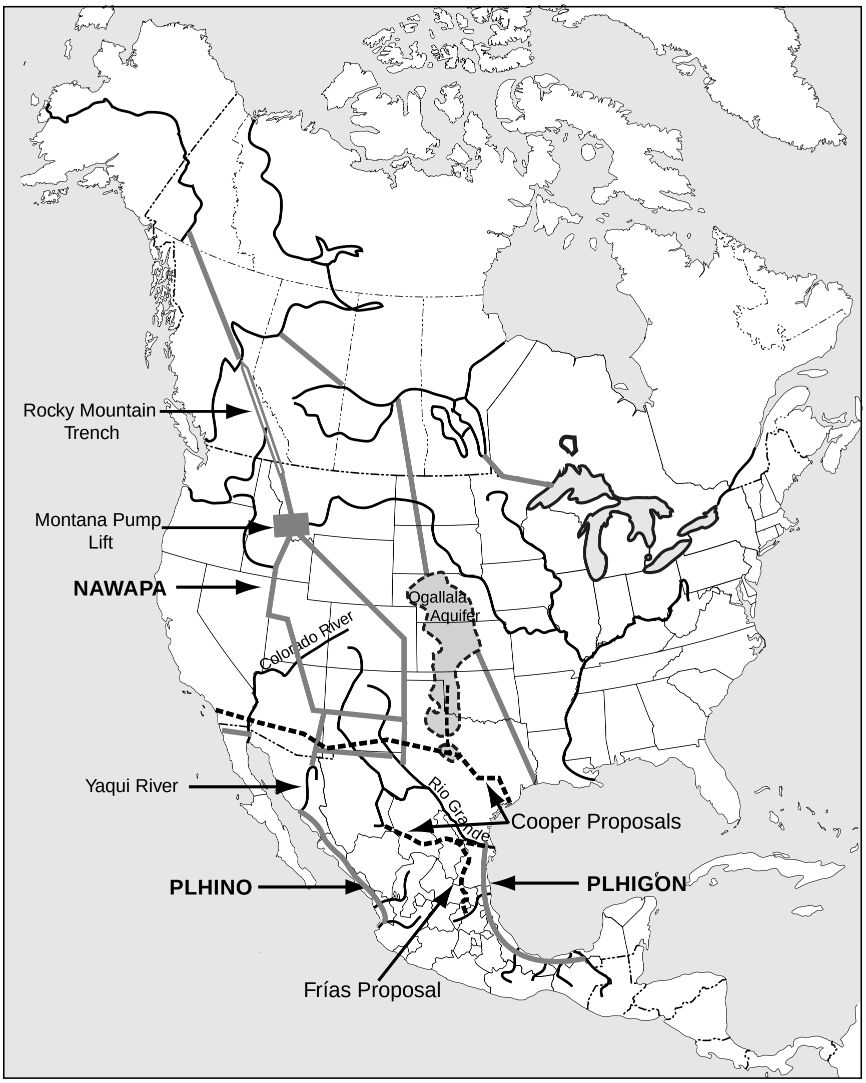
This brief philosophical excursion now gives us the grounding to be able to properly address the issue of the development of deserts, and of the Great American Desert in particular.

The MegaProject Called NAWAPA

In **Figure 11** we present a series of great water projects for North America. The main one is the famous NAWAPA project (North American Water and Power Alliance). conceived by engineers of the American company, Parsons, back in the mid-1960s, but which was never implemented because of political obstacles. NAWAPA is an integrated water, power, and agricultural project, which proposes to take about 17% of the annual runoff of the rivers of Alaska and northern Canada (some 1,000 cubic kilometers of water), most of which now flows unused into the Arctic Ocean, and to channel it southward to Canada, the United States, and Mexico. We are talking about enormous quantities of water: some 165 km^3, more than double the annual withdrawals from all of Mexico today, or more than one-third of annual

FIGURE 11

North America: Great Water Projects



Sources: Parsons Company, *North American Water and Power Alliance Conceptual Study,* Dec. 7, 1964; Hal Cooper; Manuel Frías Alcaraz; *EIR.*

U.S. withdrawals.

According to the original design by Parsons—which, incidentally, was one of the leading companies that designed and built the Hoover Dam on the Colorado River in the 1930s—the water would first be channelled into the Rocky Mountain Trench, a natural reservoir some 800 kilometers (500 miles) in length which runs from the center of Canada down into the northern United States, and which is about 15 kilometers (10 miles) wide and some 100 meters (330 feet) deep, on average. It would store some 400-500 cubic kilometers of water, at a height of about 900 meters above sea level.

Cutting across the extreme northern tip of the Trench, a navigable waterway would be built in Canada, from Vancouver in the west to Lake Superior and the St. Lawrence Seaway in the east—a great waterway that would connect the Pacific with the Atlantic.

The eastern branch of NAWAPA would run south from this Canadian canal, through the center of the United States, where it would help to recharge the gigantic Ogallala Aquifer, which today is overexploited. From there, another canal would connect it to the Gulf of Mexico. At the extreme southern tip of the Rocky Mountain Trench, the Montana Pump Lift would be built, a pumping station that would lift the water from 900 meters above sea level to some 1,500 meters above sea level, on both sides of the continental divide in the Rockies. It is estimated that this would require some 80 billion watts (80 Gigawatts) of energy, a substantial amount, but the total plan proposes to build numerous hydro-electric dams along NAWAPA's entire route, which would produce some 180 GW of energy. In other words, even after using 80 GW for the Montana Pump Lift, there would be a net surplus of some 100 GW.

From there, the central branch of NAWAPA would run along the eastern side of the Rockies, cutting across the Great American Desert through the states of Wyoming, Colorado, New Mexico, and Texas. There, it would connect with the tributaries of the Rio Grande (Rio Bravo), which forms the border between the United States and Mexico at that point. This would enable the transfer of large quantities of fresh water—some 6.8 km^3, according to the original Parsons design—to the arid center-north of Mexico, that is, to the region encompassed by the six states of our study.

The western branch of NAWAPA would also cut through the Great American Desert, crossing the states of Nevada, Utah, Arizona, and New Mexico, where it would also feed into the Rio Grande, and would re-connect with the central branch of NAWAPA. From Arizona, a new canal would be built to carry water across the border to Mexico, to the Yaqui River in Sonora, which would receive nearly 12 km^3 of water a year. This western stretch of NAWAPA would also supply water to the north and center of California, and to the Colorado River, which in turn, would carry more than 5 km^3 of water a year to North Baja California.

NAWAPA is, without a doubt, a *great project*—a project that would change the very face of the Earth in the region of the Great American Desert, producing the kind of "geological changes" that Vernadsky spoke of. 10,000 kilometers of canals and 2,900 kilometers of tunnels would be built. The construction would take 20-30 years to complete—but the first benefits would begin to accrue in less than a decade. It is estimated that it would cost some $800 billion. That may sound like a lot of money, but it is about the same as what the international drug trade banks each year, or about half of the 1.6 trillion dollars in speculative financial flows that are carried out around the world *every day*.

In any case, there is no fundamental problem in financing this project and all the others that we propose here. As LaRouche has explained, all you have to do is put the IMF global financial system into bankruptcy reorganization; establish a New Bretton Woods, a new international financial system, that would encourage international cooperation on these kinds of great projects; and set up national systems of credit and banking that would penalize speculation, while issuing cheap, long-term credit for infrastructure development projects which are in the general welfare.

More than money, what is lacking to build projects such as NAWAPA, is political will. The best approach would be to take NAFTA and toss it on the trash heap, and replace it with NAWAPA-style cooperation on great infrastructural projects among Mexico, the United States, and Canada. We must return to a sense of "we can do it!" optimism, of the sort the United States experienced under Roosevelt during the 1933-1945 period; or, that Mexico had more recently, under the Presidency of José López Portillo (1976-1982). For example, in 1977, President López Portillo responded to an interviewer's question about NAWAPA: "It is an extraordinarily interesting project, but very costly. Surely it will take place one day. That will be when we have sufficient energy to handle large bodies of water."

We will turn to this issue of energy further ahead.

NAWAPA would increase available fresh water in Mexico by some 25 km^3, which is 35% of the current total national withdrawal (see **Table 8**). And in the six states of the Northern Development Zone, the additional flow of 6.8 km^3 of water to that region would mean a whopping 68% increase. In the United States, NAWAPA would increase available fresh water by 98 km^3 (a 21% increase over current national withdrawals), and 62% of that increase would go to the seven states of our study. There, NAWAPA would mean a 49% increase over current withdrawals. Table 8 shows the increases, state by state. In several cases, as with Arizona, New Mexico, and Nevada, NAWAPA would *double* the amount of available fresh water.

TABLE 8

NAWAPA Compared to Current Annual Water Withdrawals

(Cubic Kilometers)

	Current	NAWAPA	NAWAPA as % of Current
Mexico	**72.0**	**25.0**	**35%**
6-state Region	**10.0***	**6.8**	**68%**
United States	**469.0**	**98.7**	**21%**
Nevada	3.0	5.0	158%
Utah	6.0	3.7	62%
Colorado	19.0	2.5	13%
California	50.0	12.3	25%
Arizona	9.4	12.3	131%
New Mexico	4.9	11.1	229%
Texas	33.6	14.8	44%
7-state Region	**126.0**	**61.7**	**49%**

*Estimated

Sources: FAO; U.S. Geological Survey; Parsons Company; *EIR*.

Other Great Water Projects

Although NAWAPA is a must if we are to exert dominion over the Great American Desert, there are a number of other water projects that are complementary and are to be recommended. For example, in Figure 11 we also present the Northwest Hydraulic Plan (PLHINO) and the Northern Gulf Hydraulic Plan (PLHIGON) in Mexico. The PLHINO would capture water from the Ameca River and others in the states of Michoacán and Nayarit and, with the help of a series of dams and canals, would bring it north along the Pacific Coast, passing through Sinaloa to Sonora, where there is very fertile, but also, very arid land. There, it would connect with the NAWAPA megaproject, through the Yaqui River. Some nine dams which are part of the PLHINO design have already been built, and six others have been identified and need to be built to complete the project.

The PLHIGON would carry water from the Isthmus of Tehuantepec in southern Mexico, where there is a surplus of water, by means of a canal that would run along the entire Gulf Coast of Mexico, all the way up to the Rio Grande on the border with the United States. In this case, six of the 22 dams required have been built, and 16 others remain to be built.

It should be noted that neither the PLHINO nor the PLHIGON would carry water up to the Great American Desert, to the arid center-north of Mexico. They would have to be complemented by other projects that would bring water up from the coasts to the central highlands. From the western side, this is not very feasible in physical-economic terms, since the Western Sierra Madre is quite high—it reaches heights of 3,000 meters above sea level. But on the Gulf side, it is much more feasible, given that the Eastern Sierra Madre ranges between 2,000 and 2,500 meters above sea level.

One project that would be especially important for carrying water in that direction, at least as far as the city of Monterrey (which is just before you have to cross over the Eastern

Sierra Madre into the highlands), is a proposal developed by Mexican engineer Manuel Frías Alcaraz, and which he has dubbed the *TzenValle System.* The idea is to divert about one-third of the water from the Pánuco River (the third in the country, in terms of run-off) and its tributaries, where these originate in the Eastern Sierra Madre in the state of San Luis Potosí. By means of a series of dams, tunnels, and canals located at some 250-300 meters above sea level, water would be carried north, and then pumped up as far as Monterrey, which is at 540 meters above sea level. In other words, the cost of the pumping would be kept to a minimum, because the water would only need to be lifted an additional 250 meters or so.

The TzenValle System would carry an additional 6.8 km^3 of water per year to this arid zone—more or less the same amount that NAWAPA would bring to the region. This gives some idea of the great scope and potential of this project.

American engineer Hal Cooper has also proposed a couple of projects to carry water from the Gulf of Mexico to the Great American Desert. In the first one, he calls for building a canal that would run from the extreme north of the PLHIGON, to Monterrey, and from there to Saltillo, Torreón and into the southern part of the state of Chihuahua, where it would connect to the Conchos River, a tributary of the Rio Grande. The most challenging stretch of the project would be to raise the water from Monterrey to Saltillo, a difference of about 1,050 meters. There is no way around pumping the water up, although you could possibly build some tunnels under the highest parts of the Eastern Sierra Madre.

The relative disadvantage of building tunnels is that they require significant capital investment, more than what is required for the construction of canals and pumping stations alone. But pumping, on the other hand, has continuous operating costs associated with it, which is not the case when a tunnel is built that can save on the difference in heights. These factors have to be evaluated on a case-by-case basis.

Cooper's second project to bring water from the Gulf of Mexico to the Great American Desert, is to build a canal starting at the Gulf of Mexico near Corpus Christi, Texas, which would then run more or less parallel to the border with Mexico, crossing the states of New Mexico and Arizona, and then reach the California coast near Los Angeles. Cooper points out that an existing, but unutilized oil pipeline that runs from Victorville in southern California, to McCamey in west Texas, could be used. In this project, the water would also have to be lifted to a height of about 1,600 meters above sea level, which is the lowest pass that exists through the Rocky Mountains in that region, at Paisano Pass in Texas. The use of tunnels through the mountains would probably be very advantageous in this project.

But in Cooper's Plan, where would the fresh water to carry to the Great American Desert come from? From the *desalination* of both sea water on the coast, as well as from water retrieved from saline aquifers along the proposed route.

The most efficient power source to drive desalination plants is nuclear power (see box). One leading type of reactor is a modular High-Temperature Gas-Cooled Reactor (HTGR), capable of producing 350 megawatts. One "island" of four modular HTGR reactors could produce a total of 1,400 megawatts of power. This level of power, when transmitted to a multi-stage flash distillation desalination plant, would generate about 145 million cubic meters of fresh water per year. It would also generate, above that, 446 megawatts of net electrical output.

If one were to place, initially, 20 such nuclear islands in our selected seven-state region, each hooked up to water desalination plants, this would generate about 2.9 km^3 of new fresh water per year. As of 1996, the total U.S. desalination capacity—including both nuclear and non-nuclear techniques—was only about 1 km^3 per year. By way of comparison, Saudi Arabia, the world leader in desalination capacity, had over 2.1 km^3 per year.

The 2.9 km^3 that 20 nuclear complexes would produce equals 2.3% of the fresh water that is annually withdrawn by the seven-state region—a significant amount. If twice that number of nuclear islands were constructed, then one would be "manufacturing" about 5.8 km^3 of new, fresh water every year—almost as much as the Frías plan would be moving through inter-basin transfer.

Moreover, the development of nuclear technology is absolutely vital on the energy front as well (as we note below), and brings with it the desired non-linear effects that come

Nuclear Desalination

Fourth-generation nuclear reactors are now ready for mass-scale introduction, with designs that are mass producible, super-safe, and nearly 50% more efficient than conventional reactors. These reactors are ideal for supplying the energy to produce potable water from seawater.

Two of these modular fourth-generation reactors are now in development: The German-developed pebble bed modular reactor (which uses fuel pellets the size of tennis balls) is under construction in South Africa, with fully tested components for safety and output; and the San Diego-based General Atomics company, which pioneered the idea for using fuel particles (small, ceramic-encased spheres of fission fuel ("mini-containment vessels") is jointly developing a modular high-temperature helium-cooled reactor with Russia, to burn weapons-grade plutonium as fuel.

A desalination plant coupled to a 135 MW fast breeder reactor has operated in Kazakstan since 1973, and Japan has several small desalination units attached to its operating nuclear plants.

In the 1980s, General Atomics was involved with desalination plans for the Metropolitan Water District of Southern California, which serves the large desert population of more than 15 million people. A report was prepared titled, "MHTGR Desalination for Southern California" (December 1988), through a U.S. Department of Energy contract to General Atomics, Bechtel, Inc., and Gas-Cooled Reactor Associates. MHTGR was General Atomics' earlier design of a modular high-temperature gas-cooled reactor.

As designed in the 1980s, each de-salting plant would consist of four modular nuclear reactor modules (350 MW each), using helium gas as coolant. The low-temperature heat output would fuel eight seawater desalination "trains," based on the horizontal-tube, multiple-effect distillation process. This would yield 401,500 cubic meters per day of freshwater, enough to supply 1.5 million people with sufficient potable water for domestic use. Strategic siting of 10, 20, or more such plants, on the Pacific or Gulf coasts, would mean volumes of newly created freshwater, sufficient for supplying 15-30 million or more people with their domestic water needs, or equivalent volumes for other purposes.

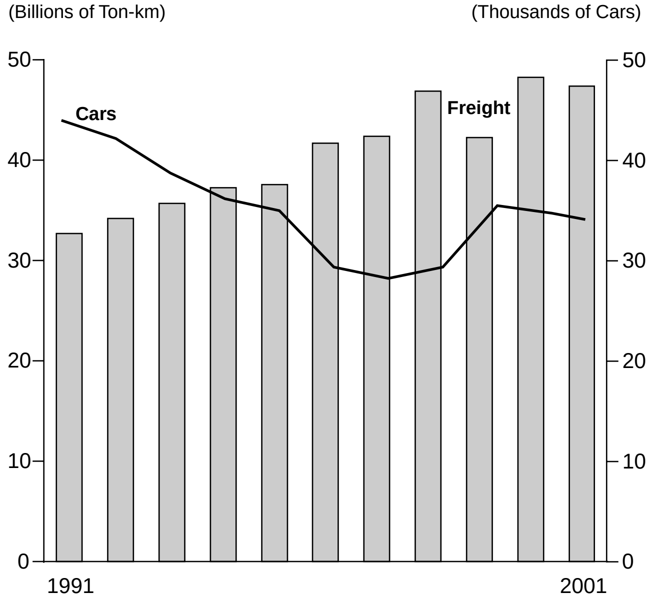
The UN's International Atomic Energy Agency estimated that: "A desalination plant with a capacity of 1 million cubic meters per day could supply an urban concentration of 3-4 million people with sufficient potable water for domestic use. Such a desalination plant, using the reverse osmosis process, would require a nuclear plant having an installed capacity of about 300 MW-electric (MWe). The same urban concentration of people also would require between 4,000 to 6,000 MWe of installed capacity to provide their corresponding electricity needs. Hence, nuclear power plants in the upper end of the small and medium-size power range—and certainly the large-size nuclear power plants—would only constitute suitable choices when they are intended to supply electricity to consumers in addition to energy for seawater desalination. Thus, there is no reason that nuclear reactors could not supply both requirements simultaneously, and take advantage of the economic benefits accuring to large-size nuclear plants."

—*Marcia Merry Baker*

Artist's depiction of a modern seawater desalination tower. It is proposed for a location on the Pacific Coast of California. The structure houses a multi-effect distillation process (vertically stacked evaporators) for large-scale output (284,000 cubic meters daily).

FIGURE 12

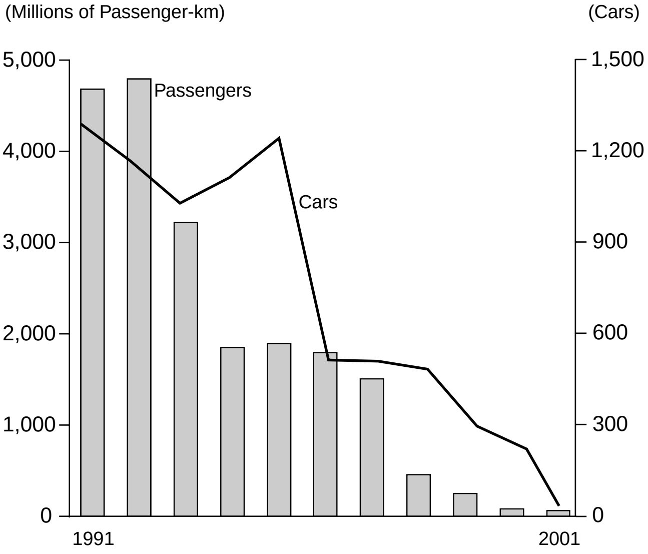
Mexico: Rail Freight



Source: Ministry of Trade and Transportation (Mexico).

FIGURE 13

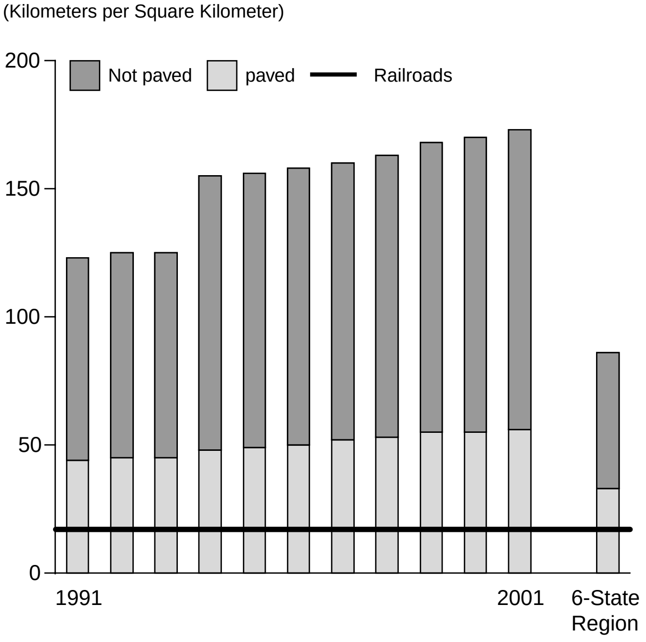
Mexico: Rail Passenger Traffic



Source: Ministry of Trade and Transportation (Mexico).

FIGURE 14

Mexico: Density of Highways and Railroads



Source: Ministry of Trade and Transportation (Mexico).

from introducing the most advanced fields of science and technology—the "geometric" changes discussed by Vernadsky and others.

Cooper suggests that one such nuclear desalination complex could be built adjacent to the Permian Basin in Texas-New Mexico, which today produces significant oil and natural gas, but also brings up, in the extraction process, a large amount of saline water. That water could be desalinated, and used. Other plants could be located on Texas's Gulf Coast; at the Rio Grande; and so forth along the proposed route of the new aqueduct. Similar nuclear desalinating plants should be constructed in Mexico, along the coastal routes of the PLHINO and the PLHIGON, as well as along the proposed route of the aqueduct carrying water into the Mexican highlands.

Great Rail Projects

We now turn to the subject of transportation, of high-speed rail systems in particular. **Figure 12** and **Figure 13** capture the pathetic situation of Mexico's railroads. In Figure 12, one can see that cargo transport by rail has stagnated at a very low level over the last decade, while the number of cargo cars has declined in absolute numbers. Figure 13 presents the picture for passenger rail transportation, which is even worse. At the beginning of the '90s,the level was already very inadequate, but over the course of the past decade it went from inadequate to virtually nonexistent. Today, there is no passenger rail transport in Mexico to speak of. In **Figure 14** we see that highway transportation is almost as bad. The graph shows the density of highways, as measured in kilometers of road per km^2 of land area. Note that only one-third of Mexico's

TABLE 9

Mexico: States Ranked by Density of Highways and Railroads

State	Highways	Railroads	Combined
Chihuahua	32	23	28
Durango	27	24	26
Zacatecas	24	25	25
Coahuila	31	16	24
Nuevo León	26	15	21
San Luis Potosí	21	14	18

Source: Ministry of Trade and Transportation (Mexico).

highways are even paved, and that the density in the Northern Development Zone is less than half the national average.

Table 9 presents the relative paucity of any transport infrastructure in the northern six states, as compared to the already very low national levels. In terms of their density of highways and railroads, per square kilometer, these states are at the bottom of the national ranking.

In the Untied States, and especially in the seven states under consideration, the railroad system is also totally inadequate.

In 1980, President Jimmy Carter supported and signed into law the Staggers Act, which deregulated the nation's rail system. The Act was the handiwork of the financier-run giant rail companies, and of Wall Street. The Act accelerated the process by which America's once-functioning rail grid was looted, starting in the 1960s. **Figure 15** presents one parameter of this devastation: For Class I railroad carriers (the major railroads), in 1980, there were 264,040 route-kilometers (164,000 route-miles) of railroad in operation; in 2000, there were only 159,800 route-kilometers (99,250 route-miles) in

TABLE 10

U.S.: Kilometers of Railroad Track, Per Million Population

State	1980	1990	2000
Nevada	2,742	1,929	1,543
Utah	1,733	1,326	1,272
Colorado	1,741	1,603	1,110
California	422	332	278
Arizona	1,003	668	418
New Mexico	2,444	2,094	1,978
Texas	1,367	1,090	878
7 States Sub-total	**965**	**755**	**629**
United States	**1,189**	**884**	**686**

Sources: Association of American Railroads; U.S. Department of Commerce; *EIR.*

FIGURE 15

U.S.: Class I Railroad Roadway

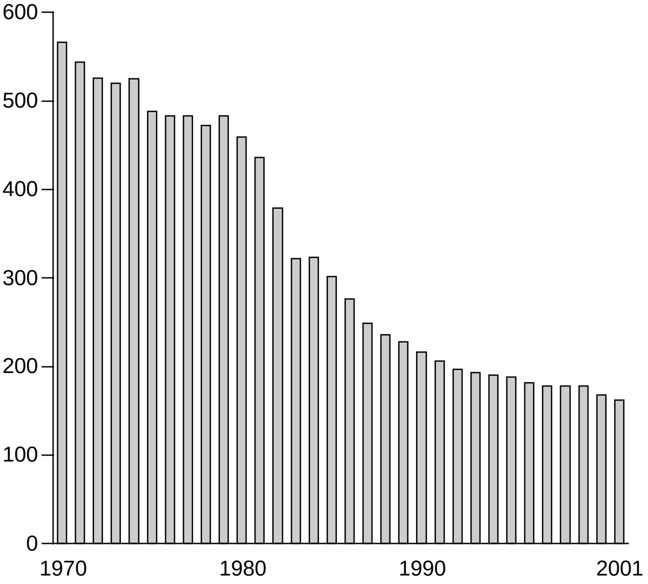
(Thousands of Kilometers)

Sources: Association of American Railroads; *EIR.*

FIGURE 16

U.S.: Number of Railroad Workers

(Thousands)



Sources: Association of American Railroads; *EIR.*

FIGURE 17

North America: High Speed Rail Lines

Sources: Hal Cooper; *EIR.*

operation, a fall of 40%. In 1980, there were 458,000 railroad workers; in 2000, there were 168,000, a drop of 63% (**Figure 16**). In 1980, there were 1,168,114 freight cars in operation; by 2000, that was down to 560,154, a collapse of 52%.

Within this process, the seven-state region's railroad grid, already inadequate, was destroyed further. **Table 10** shows that for the seven-state region, the amount of existing railroad track has fallen from 965 kilometers per million persons in 1980, to 630 kilometers per million persons in 2000, a decline of 35%.

To develop the Great American Desert, and more broadly, the nations of Mexico and the United States, a high-speed, electrified rail network must be built (**Figure 17**). A sound rail system is a *sine qua non*, both to impart higher productivity and as a transport net within which to build manufacturing, agriculture, and civilization more generally. Although many of the rail lines shown on our map already exist, in one form or another, they all have to be upgraded and expanded, with double tracking and electrification to tolerate high-speed trains.

These high-speed rail lines should then be further upgraded, as quickly as possible, to magnetic-levitation (maglev) systems, which can move people at speeds of 350-450 kilometers per hour (220-280 miles per hour), and freight in excess of 200 kilometers per hour (125 miles per hour). Maglev would more than double the current rail speed at which both passengers and freight are moved in the United States.

Figure 17 shows four such proposed north-south routes in the United States, and two east-west lines. These are critical routes for high-speed rail transportation, which would transport both people and goods within the seven-state region, and from this region to other important parts of the country and, most significantly, to link up with a similar Mexican high-speed rail network.

In Mexico, we propose three principal high-speed electrified north-south rail lines (Mexico City-Nuevo Laredo; Mexico City-Ciudad Juárez; and Mexico City-Tijuana), each of which would link up with the U.S. system. Additional east-west spurs should be built to link Monterrey to Saltillo and Torreón, and from Mexico City down to the Isthmus of Tehuantepec and the Yucatán Peninsula.

Of all these, perhaps the most urgent is the middle north-south route, which runs from Mexico City to Ciudad Juárez, and would link the entire Northern Development Zone to its natural economic and political center, Mexico City. This would further serve to help bring about national cohesion between northern and central Mexico, and put an end to the destructive tendency we see today, of Mexico's northern area being spun off centrifugally into a free-trade no-man's-land, more aligned with Wall Street than with Mexico City.

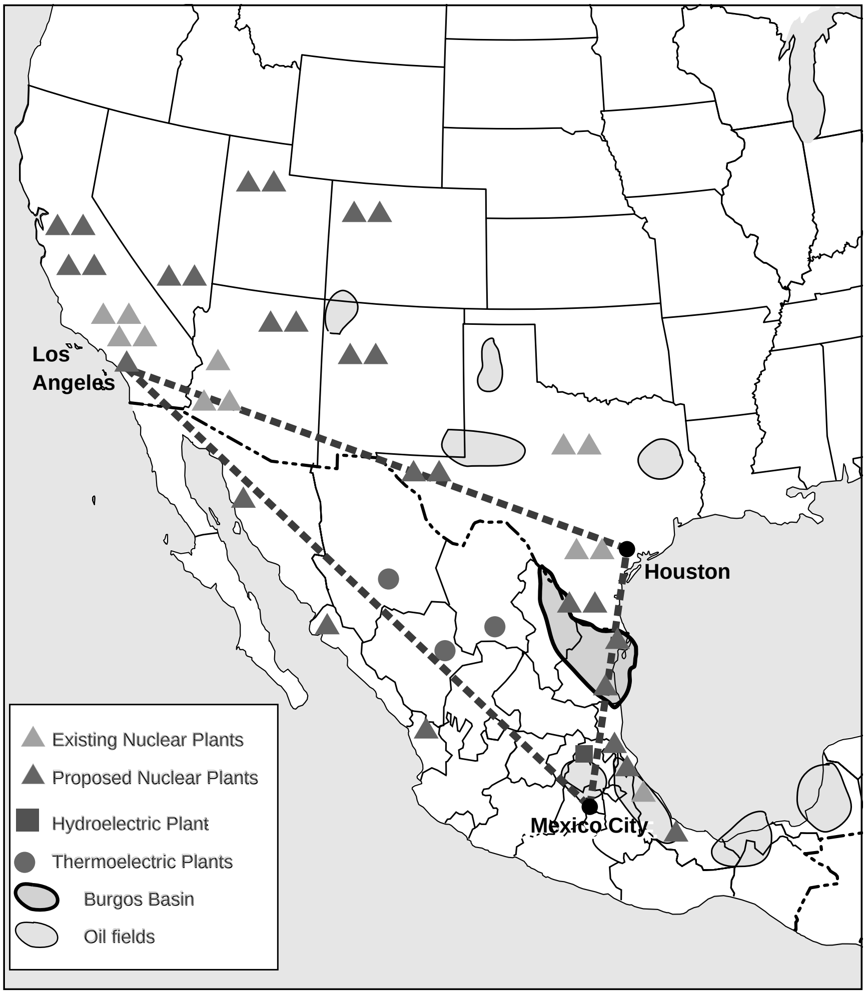
The three principal north-south lines in Mexico alone amount to about 7,000 km of newly refurbished and upgraded rail track—a sizeable project which will also bring about the productive employment of many million Mexicans. For starters, it will take something in the order of 1.6 million tons of steel and 2.3 tons of cement alone, to build this amount of track. Those are 12% and 8% increases, respectively, in the current Mexican production of those two goods.

For purposes of comparison, the "skeletal" rail system required for South America as a whole, under the World Land-Bridge as presented in Figure 1 of this study, is about 24,000 km, or three and a half times the Mexican lengths.

But both Mexico and the United States must also look beyond their borders, to the broader world, where the Eurasian Land-Bridge is rapidly moving forward. In fact, both the United States and Mexico, as well as the rest of the Americas, are today isolated from that Eurasian great project. To establish the necessary geo-economic links, a tunnel must be built under the Bering Strait between Alaska and Russia, and a railroad must be constructed across the Darien Gap, between Panama and Colombia.

FIGURE 18

The U.S. and Mexico: Great Energy Projects



Sources: Hal Cooper; *EIR.*

Power and Nuclear Energy

The positive transformation of the bi-national region requires a sizeable increase in energy throughput, and, in particular, of electricity. This will include energy for water desalination and for high-speed rail, as mentioned previously, but also for every facet of economic life, such as powering industry, transportation, and the functions of the home. At the center of modern industrial and agricultural life is electricity, the very concentrated and energy-dense form of energy.

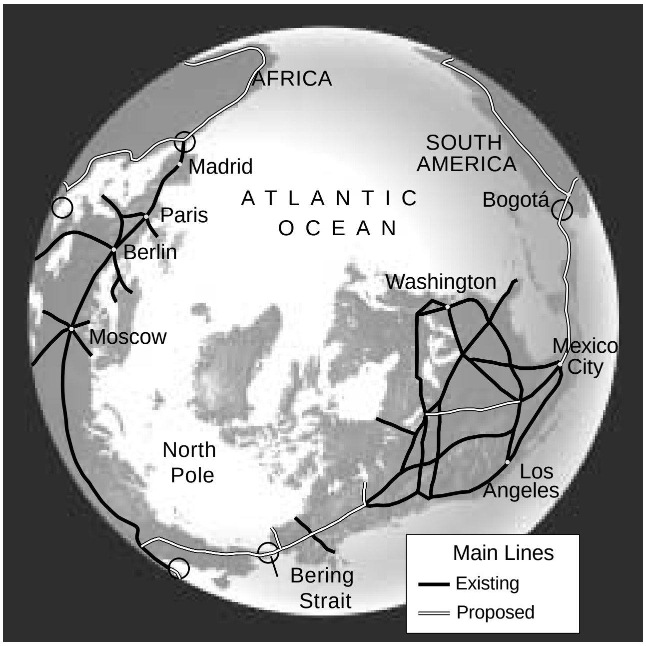
There is much hydro-electric potential in the region, as well as sizeable oil fields and the newly discovered Burgos Field of natural gas in northeastern Mexico (see **Figure 18**). But increasingly, the dominant form of new energy in both countries must be nuclear. This is not only because nuclear energy has, by far, a higher energy-flux density than either hydro-electric or any form of thermal power, but because nuclear energy means the associated development of advanced technologies and basic science, which alone guarantees the true development of the Noösphere. In other words, nuclear means greater *power* per unit energy.

As for Mexico, it must return to President López Portillo's policy of exchanging *oil for technology*—and it can now throw natural gas into the package as well. Only such an approach guarantees the proper trajectory for the nation's development, by optimizing the rate of scientific-technological advance. And it also lays the foundation on which proper U.S.-Mexican relations can be rebuilt, as LaRouche has long insisted.

As for the U.S. seven-state region, it currently consumes 24.5 quadrillion Btu of energy, which is one-quarter of the United States' energy consumption. It has an electricity generating capacity/capability (at Summer peak) of 175,949 megawatts, which clearly must be increased. Some of the increased capacity will come as hydro-electric power, as a natural spin-off from the NAWAPA project. N.W. Snyder

FIGURE 19

The World Land-Bridge, Polar Projection



Source: *EIR*.

of the Parsons engineering firm, in a 1980 paper, projected that by building dams and generating systems along the NAWAPA water route, there would be 8,700 megawatts of added electric generating capacity in these seven states, an increase of about 5% over existing levels. Furthermore, the proposed construction of 20 nuclear "islands," to power desalination plants, would generate 8,920 megawatts of electric generating capacity above what is needed to power the desalination plants. This 8,920 megawatts would increase the region's electric generating capacity by an additional 5%.

Consider the regional Great American Desert development process as a triangle, of sorts. One vertex of the triangle would be the region around Houston, Texas; a second vertex would be the region around Los Angeles, California; and a third vertex would be Mexico City and surrounding areas, where half of Mexico's population and 70% of its industry is concentrated. These three are the regions of greatest relative development.

Mexico and the United States could jointly develop the area in and around that triangle, which is approximately 85% desert or semi-arid land, having only a handful of cities of significant size, little manufacturing, and scant productive economic activity outside of some zones of agriculture. The building of beautiful, functional cities would proceed, with a special emphasis along the primary high-speed rail-line corridors. The tremendous new flows of water and electricity generation within the corridors would create a flourishing of manufacturing, mining and refining, and agriculture to provide vastly upgraded productive employment to the people of both nations.

It is useful, conceptually, to take a step back from this triangle—way back. The proper image we should have is that of **Figure 19.** This is the World Land-Bridge, seen from a polar viewpoint. It conveys the idea that the entire planet is one; that the World Land-Bridge is a single continuous route that can integrate and develop it as a whole, from Tierra del Fuego in South America to Cape of Good Hope in Africa. It reminds us of the fact, shown by Vladimir Vernadsky, that the Noösphere is the highest expression of this planet and of the entire created universe, and that the human mind and creativity is what defines and imposes the metric upon all other aspects of physical-economic development. The laws of development of the abiotic world and the biotic world, are both subject to human laws of willful creativity. That creativity is both the parameter, as well as that which must be maximized in the process of development.

Why do something easy? Let's take on a real challenge, such as colonizing Mars. Let's do something difficult; let's develop the deserts of the Earth, and let's do it on the basis of North-South cooperation. That is the significance of LaRouche's Great American Desert Development Project.