

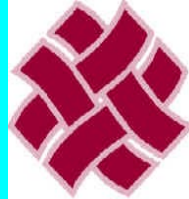
AQUIFERS AND FREE TRADE: AN HERMOSILLO COAST CASE STUDY

English Summary Document



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I. INTRODUCTION

The enactment of the North American Free Trade Agreement (NAFTA) has substantially altered the relationship between Mexico and the United States. While discussions related to the Agreement have primarily focussed on trade between the two countries, in recent years, discussions have addressed how the opening of new markets and investment opportunities have impacted current and future sustainability of natural resources. Strategic natural resources – like water reserves – have been part and parcel of this discussion through the years, as evidenced by the recent disputes between the U.S. and Mexico over water quantity in rivers like the Rio Conchos, and over the poor water quality supplied by the Colorado River to Mexico.

The agricultural sectors of both countries have been especially sensitive to changes related to NAFTA. In general, the Agreement has meant a gradual opening of Mexican grain markets to North American exports and an opening of United States markets to Mexican fruit and vegetable exports. While the ultimate impacts of NAFTA might not be felt until the gradual tariff elimination process ends in 2009, initial evidence – as detailed in this report -- points to a growing disparity between Mexican and U.S. farmers in the production of traditional grains like sorgum and corn, and a growing dependency on U.S. markets for new export crops grown in Mexico.

The Mexican state of Sonora is a prime example of how the Mexican economy has transformed since NAFTA. While agricultural and livestock activities had slowed during the late 1980s and early 1990s, with the advent of NAFTA there has been renewed investment in agriculture in the state, principally in export fruit and vegetable crops. This has had both social and environmental consequences. One such consequence is the threat to natural resources, which has increased heavily over the last half century as economic growth and crop selection strain the arid ecosystem.

The Red Fronteriza de Salud y Ambiente, A.C., and the Texas Center for Policy Studies have jointly published a report, ***Acuíferos y Libre Comercio: El Caso de la Costa de Hermosillo***. The report analyzes the influence that economic integration policies such as NAFTA have had on the Sonoran socioeconomic structure. In addition, the report investigates the condition of the underground aquifer along the Hermosillo Coast, one of the principle agricultural regions in Mexico. The region has traditionally based its economic growth on the exploitation of underground reserves that are diminishing and facing increased saltwater intrusion.

The future of Sonora seems to include a profound transformation in the agricultural-commercial power structure. The report investigates to what degree NAFTA has promoted and facilitated this transformation through its emphasis on foreign trade. Finally, the report discusses the environmental consequences for a region that bases its development on the exploitation of an imperiled state aquifer. Given the strategic value of water rights in the border states of north Mexico, the analysis is presented in terms of water use by sector and potential consequences to the sustainability of the region.

II. NAFTA EFFECTS ON AGRICULTURAL SECTOR IN MEXICO AND SONORA

A. NAFTA Impacts on Mexican Agriculture

Since the enactment of NAFTA in 1994 – and more accurately since Mexico’s 1986 entry into the General Agreement on Tariffs and Trade (GATT) – Mexican agriculture has had to adjust to increasing economic integration. Although it is difficult to determine the exact impacts of this integration on Mexican growers, it seems clear that agriculture in Mexico has changed, with more crops destined for export and more imports of basic grains from the United States.

Much of this change is due to tariff and quota reforms. In the case of corn, for example, NAFTA gradually reduced tariffs and quotas on corn imports to Mexico, allowing more corn from the United States to enter Mexico without duties. In 2000 the first 2.98 million tons of corn entered without a duty, while all imports beyond that had a tariff of 145.2% above the price. By the year 2008, the corn quotas and tariffs will be eliminated.

Table 1. Import Quotas from the United States without Tariffs and with Gradual Tariff Reduction, 1994 – 2008

Year	Tons from USA	Tariff Ad-Valorem Base=215%	Imports in tons from USA
1994	2,500,000	206.4	3,054,111
1995	2,575,000	197.8	2,858,829
1996	2,652,250	189.2	6,314,387
1997	2,731,817	180.6	2,566,142
1998	2,813,772	172.2	5,245,670
1999	2,898,185	163.4	5,051,767
2000	2,985,131	145.2	5,194,328
2001	3,074,685	127.1	
2002	3,166,925	108.9	
2003	3,261,933	90.8	
2004	3,359,791	72.6	
2005	3,460,584	54.5	
2006	3,564,402	36.3	
2007	3,671,334	18.2	
2008	Free	0.0	

Source: FIRA, Development Opportunities for Mexican Corn; Informative Bulletin Number 309; Mexico, October 1998; and FATUS, Foreign Agricultural Trade of the United States. Foreign Agricultural Trade of the United States Database. Available at <http://www.ers.usda.gov/db/fatus>.

An analysis of Mexican corn production between 1994 and 2000 shows a drop in volume and in cultivated area, suggesting that some growers could not survive the new open market. For those that did, however, productivity actually increased. Domestic corn production levels remained stable while demand *increased*. Imports have risen to react to the growing demand – mostly to feed livestock – growing from 3.1 million metric tons

in 1994 to 5.3 million metric tons in 2000. Other basic grains such as wheat have shown similar tendencies in their imports from the United States. Unground wheat imports rose from 625,000 to more than 1.7 million metric tons, while sorghum rose from 3.4 million to 4.7 million metric tons in the same six-year period.ⁱ

Beyond tariff and quota reductions under NAFTA, the rise in imports is also due to the elimination of the state organization CONASUPO (National Company of Popular Subsistence) in the 1990s. CONASUPO had bought large quantities of basic grains at guaranteed prices, and its elimination forced basic grain producers to compete at lower prices in a time when the price of grain and corn was falling.

Table 2. Changes in Mexican Corn Production since 1994

	Percentage Difference – 2000 vs 1994
Total Consumption (Human and Livestock)	+8%
Production (Tons)	-3%
Area Cultivated	-8%
Area Planted	-13%
Productivity (Tons/Hectare)	+6%
Imports from USA as percentage of total consumption	+10%

Source: Center for Agricultural Statistics, SAGAR y FATUS, Foreign Agricultural Trade of the United States. Foreign Agricultural Trade of the United States Database. Available at <http://www.ers.usda.gov/db/fatus>.

Analysis shows that economic liberalization has had the greatest impact on corn production in northern Mexican states.ⁱⁱ While the traditional grain production states like Oaxaca and Chiapas have continued and even increased corn production, Sonora and Sinaloa have seen a strong shift away from corn and sorghum and toward the production of new crops, such as grapes, oranges and legumes. In Sonora, after corn and wheat production increased at the start of the 1990's, the planted areas fell rapidly, reaching half of their 1990 levels by 2000.

Given the low prices paid for basic grains, the high cost of irrigation to grow corn and other grains in the arid North and the increased competition with subsidized United States producers, this shift not surprising.

NAFTA offers exporters in such crops as grape, citrus and legumes new access to the United States market. For example, exports of these crops from Mexico to the United States grew from 41,305 metric tons in 1993 to 80,492 metric tons in 1995. It should be noted that some fruits and vegetables exported to the U.S. are actually imported back

ⁱ FATUS, Foreign Agricultural Trade of the United States. Foreign Agricultural Trade of the United States Database. Available at <http://www.ers.usda.gov/db/fatus>.

ⁱⁱ For more discussion of the issue of corn production in the southern states versus the northern states, see Ackerman, Frank, Luke Ney, Kevin Gallagher and Regina Flores, Global Development and Environment Institute, Environmental Impacts of the Changes in U.S. – Mexico Corn Trade under NAFTA, Draft, (Montreal, Canada: Commission on Environmental Cooperation, January 2002). Available at http://www.cec.org/pubs_docs/documents/index.cfm?varlan=english&ID=637.

into Mexico as conserved and canned products, imports of which have increased significantly since NAFTA.

B. NAFTA Impacts on the Hermosillo Coast

Throughout its history, the Hermosillo Coast agricultural region has been characterized by transformations that have converted the rural environment into a privileged space for policy makers to promote agricultural modernization. The forces of economic liberalization in the years since NAFTA have facilitated the economic reorganization of the Coast but have also had serious environmental impacts due to the exhaustive exploitation of the regional hydrologic resources.

In the search for profits from the comparative advantages with North American trade partners, traditional agricultural systems that had thrived for decades on the Coast are being replaced. The new orientation toward fruits and legumes is completely transforming the regional productive system, which means not only new agreements between social actors, but also new “opportunities” for natural resource exploitation.

What follows is a brief overview of the principal factors that have helped establish new integration patters in the agricultural region of the Hermosillo Coast:

1. Strategic Partnerships

Families whose capital has come from the service sector, industry, political activity or other sources have formed alliances to invest in agricultural projects that offer high returns. In addition, new commercial associates in California, Chile or the rest of Mexico are benefiting from the “rescuing” of bankrupt growers by other agricultural companies that then liquidate the debts by acquiring property. The consolidation of growers has led to agricultural companies increasingly oriented toward the production of fruits and vegetables for export.

2. Financial Diversification

The National Bank for Foreign Trade (Bancomext) and the Trust Fund for Agriculture of the Bank of Mexico (FIRA) have increased their credit lines for growers. However, agricultural activity on the Coast depends more and more on financing from distribution companies located in the United States who, through their brokers, grant money, inputs and technical assistance in the production, logistical support and export of the crops.

3. Commercial Integration

The organization of trade networks is now largely determined by demand in United States markets. A well-integrated system exists for storage and transport, which starts in the agricultural fields, passes through a series of refrigerators owned by growers and the government, and moves through the principal highways of the state.

4. Technological Innovation

The export crops from the Coast compete in quality and output with the best in the world. This is possible due to the physical infrastructure and continuous improvements that the growers oversee.

5. Quality Standards

The requirements imposed by the United States on its imports have forced growers to observe restrictions on herbicides and to pay more attention to aspects of health and safety.

6. Labor Systems

Flexible contracts and the need for specialized labor has given rise to various labor networks that attract agricultural workers from across the country and even from United States border states, depending on productive cycles.

7. Labor Solidarity

The power of private agricultural interests has allowed them to present a unified front when influencing public policies over labor issues and to place representatives into key government posts to push their political and economic interests.

8. Public Resource Management

Basic service infrastructure and governmental agriculture stimulation programs have been oriented toward supporting the agricultural export sector. At the same time, bank “rescue” measures have made it possible for many growers to recover from previous administrative failures, and the public subsidy system has softened the effects of unscrupulous resource management.

9. Control of Hydrologic Resources

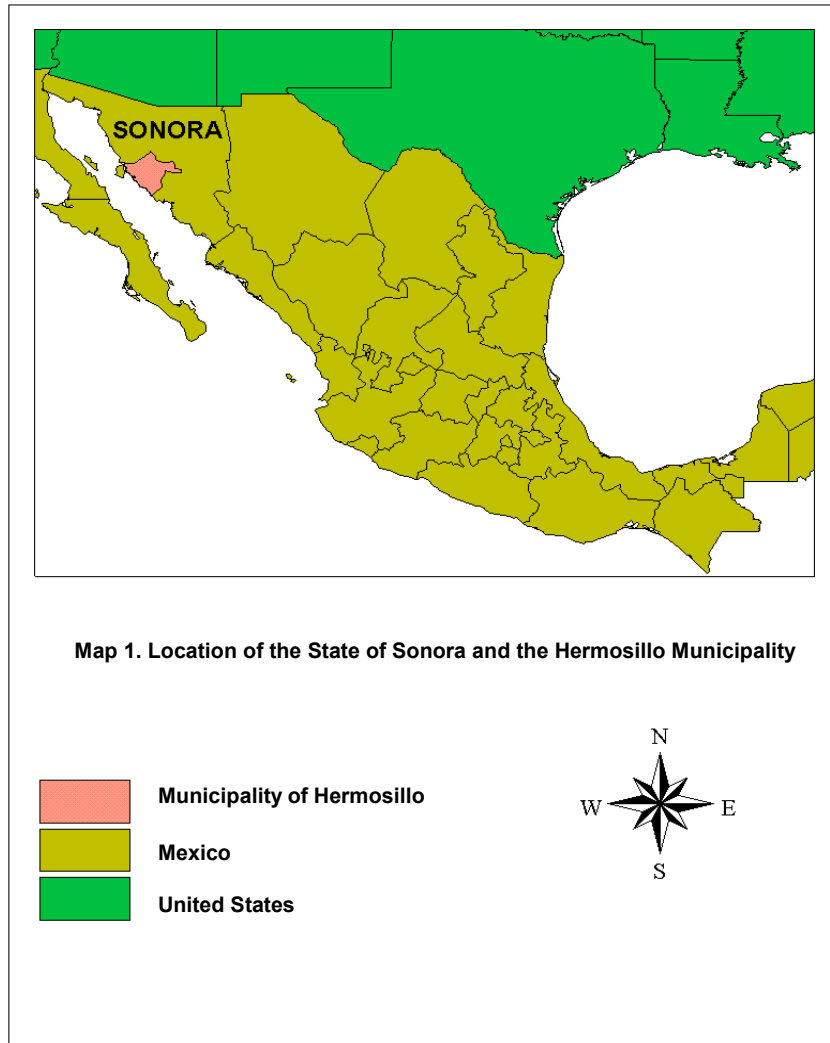
Economic activity on the Coast has been made possible by water reserves that were filled over thousands of years. For half a century, water had been under the control of the federal government, but the National Water Commission (CNA) delegated control of irrigation use to the *Irrigation District 051 Users' Association of the Hermosillo Coast* in October 1993, following changes in the National Water Law in 1992.

This Users' Association was created by District growers and is dominated by the largest agricultural families on the Hermosillo Coast. The Users' Association received a 20-year concession to manage the annual extraction of 409 million cubic meters of water. By controlling this most strategic of natural resources, the Association has gained unprecedented power in the agricultural and water markets.

III. AGRICULTURE IN SONORA AND THE COASTAL DISTRICT

A. Location of the State and Importance of Agriculture

Located along the United States border in northwestern Mexico, the state of Sonora is the second largest in the country, behind Chihuahua. Its population is relatively small, with approximately 2.2 million people (2000 Census). Approximately 610,000 of the residents live in the capital municipality of Hermosillo.



Although Sonora is characterized by a semiarid climate with large deserts and few inhabitants, agriculture has always been important in its history. In 1960, for example, agriculture, forestry and fishing accounted for nearly 35% of the state economic revenues. With the expansion of the service sectors in industrial centers like Nogales and Hermosillo, agriculture, forestry and fishing fell to 11.85% of the state economy in

1999. These sectors remain an important source of revenues, exports and jobs, however, accounting for 17.1% of employment in 2000.

Table 3. Distribution of the Gross Domestic Product of Sonora by Sector, 1960-2000

Year	Total	Agriculture, Livestock, Fishing and Forestry	Mining	Manufacturing	Construction	Electricity	Services and Communication
1960	100	34.90	2.5	4.80	3.10	1.50	53.09
1970	100	26.00	1.92	7.05	3.91	1.88	58.46
1980	100	16.75	7.89	11.00	10.04	1.38	52.93
1990	100	14.50	8.73	12.05	8.59	1.86	54.34
2000	100	16.30	7.3	12.4	10.0	3.9	50.0

Sources: State Government of Sonora, *Current Situation of the Agricultural, Livestock and Forestry Sectors in Sonora, 1997* and Ministry of Development Planning and Public Expenditure, *State Government of Sonora, 2001*.

Today, approximately 3.8% of the state – 700,000 hectares – is used for agricultural production (see Table 4). Although the 1999 total ranked Sonora only 18th in planted acreage among states in Mexico, almost 95% of this area was irrigated, and only the state of Sinaloa had more irrigated agricultural land (see Table 5).

Table 4. Distribution of Soil Use, State of Sonora, 1997

Activity	Hectares	Percent
Agriculture	700,000	3.8
Irrigated	650,000	3.5
Rain-fed	50,000	0.3
Ranches	15,402,950	83.0
Forest	200,000	1.1
Other Uses, including Urban/Industrial	2,240,100	12.1
Total	18,543,050	100.0

Source: Government of the State of Sonora, *Current Situation of the Agricultural, Livestock and Forestry Sectors in Sonora, 1997*

As with many other states, the leading agriculture products are traditional crops such as wheat, corn, beans, safflower and cotton. There is a marked increase in the production of non-traditional crops, however, such as fruits – oranges, watermelon and grapes – and vegetables – tomatoes, green chiles and potatoes. In general, basic grain production has fallen in recent years while the production of fruits and vegetables has increased. Of all Mexican states, Sonora produced the most wheat for grain, jalapeño

chiles, watermelons, grapes and asparagus and was second in garbanzos, potatoes, melon, Mexican Succotash and alfalfa (Table 6).

Table 5. Summary of Planted Crops in Sonora, Compared to other States, 1999

State	Planted Area, Irrigated (hectares)	State Rank	Total Planted Area, Irrigated + Rain-fed (hectares)	State Rank
Chiapas	59,598	25	1,533,913	3
Guanajuato	478,298	3	1,059,248	9
Jalisco	231,233	6	1,413,421	4
Michoacán	408,493	4	1,152,699	8
Oaxaca	81,053	19	1,183,781	7
Puebla	147,861	11	1,001,771	10
Sinaloa	754,855	1	1,283,078	5
Sonora	531,173	2	569,317	18
Tamaulipas	213,882	7	1,579,611	2
Veracruz	87,188	18	1,664,157	1
Zacatecas	157,992	9	1,300,683	6
National Total	4,904,014		21,983,180	

Source: SAGAR, Center for Agricultural Statistics, Annual Agricultural Statistic Bulletin, 1999.

Table 6. Cyclical and Perennial Irrigated Crops, State of Sonora, 1999

Crop	Planted Area (Ha.)	Harvested Area (Ha.)	Production (Tons)
Alfalfa	17,421	16,499	193,480
Cotton	37,631	37,138	125,012
Safflower	65,956	65,956	164,059
Green Chiles	6,083	6,083	87,015
Beans	8,945	8,722	13,990
White Garbanzos	7,301	7,301	14,047
Corn	56,925	55,075	305,263
Oranges	8,998	8,812	168,637
Potatoes	5,389	5,379	140,576
Watermelon	7,058	6,905	217,321
Wheat	203,476	202,819	1,242,524
Pecans	2,891	2,889	5,008
Green Tomatoes	3,283	3,283	32,568
Grapes	28,147	28,138	374,617

Source: SAGAR, Center for Agricultural Statistics, Annual Agricultural Statistic Bulletin, 1999.

Many of the products that have seen increased production are destined for export (Table 7). Between 1998 and 1999, agricultural exports grew from \$295 million to \$475 million. Among the most exported products are wheat, grapes, watermelon, melons, green chiles and oranges (Table 8). While wheat is exported to Africa and Europe, fruits and vegetables mostly go to the United States.

Table 7. Exports by Sector, State of Sonora, 1998 – 1999 (millions of dollars)

Sector	1998	1999	Rate of Growth (%)
Total	5,512	5,495	(0.3)
Primary	451	768	70.5
Agriculture	295	475	60.9
Livestock	112	143	28.3
Fisheries	44	150	243.0
Industry	5,062	4,726	(6.6)
Mining	496	338	(31.9)
Maquiladora	2,811	2,818	0.2
Automotive	1,588	1,411	(11.1)
Other Manufacturing	167	160	(4.0)

Sources: SECOFI, Bank of Mexico, Ministry of Development Planning and Public Expenditure, State Government of Sonora, Ford Plant, CEMEX, Ministry of Agricultural Development and Ministry of Livestock Development.

Table 8. Volume of Agricultural Exports in Sonora, by Crop (Tons)

Crops	1997-1998	1998 –1999
Total	654,291	748,575
Broccoli	2,132	1,263
Mexican Succotash	23,883	1,058
Kabocha Squash	4,371	8,881
Cauliflower	0	54
Scallion	13,401	23,051
Chiles	19,628	19,039
Asparagus	15,000	25,760
Radish	2,366	6,294
Cabbage	2,237	3,772
Tomato	19,516	11,656

Crops	1997-1998	1998 –1999
Honey Dew Melon	49,437	37,404
Cantaloupe Melon	43,349	44,700
Watermelon	86,184	94,017
Table Grape	94,775	99,706
Orange	13,898	34,435
Pecan	1,280	0
Wheat	226,838	337,472
Garbanzos	4,479	13
Vegetables	31,517	0

Source: Secretary of Agricultural Development, State Government of Sonora.

The majority of Sonora's agricultural production is contained within 7 irrigation districts in the state of Sonora. These districts are briefly described in Table 9.

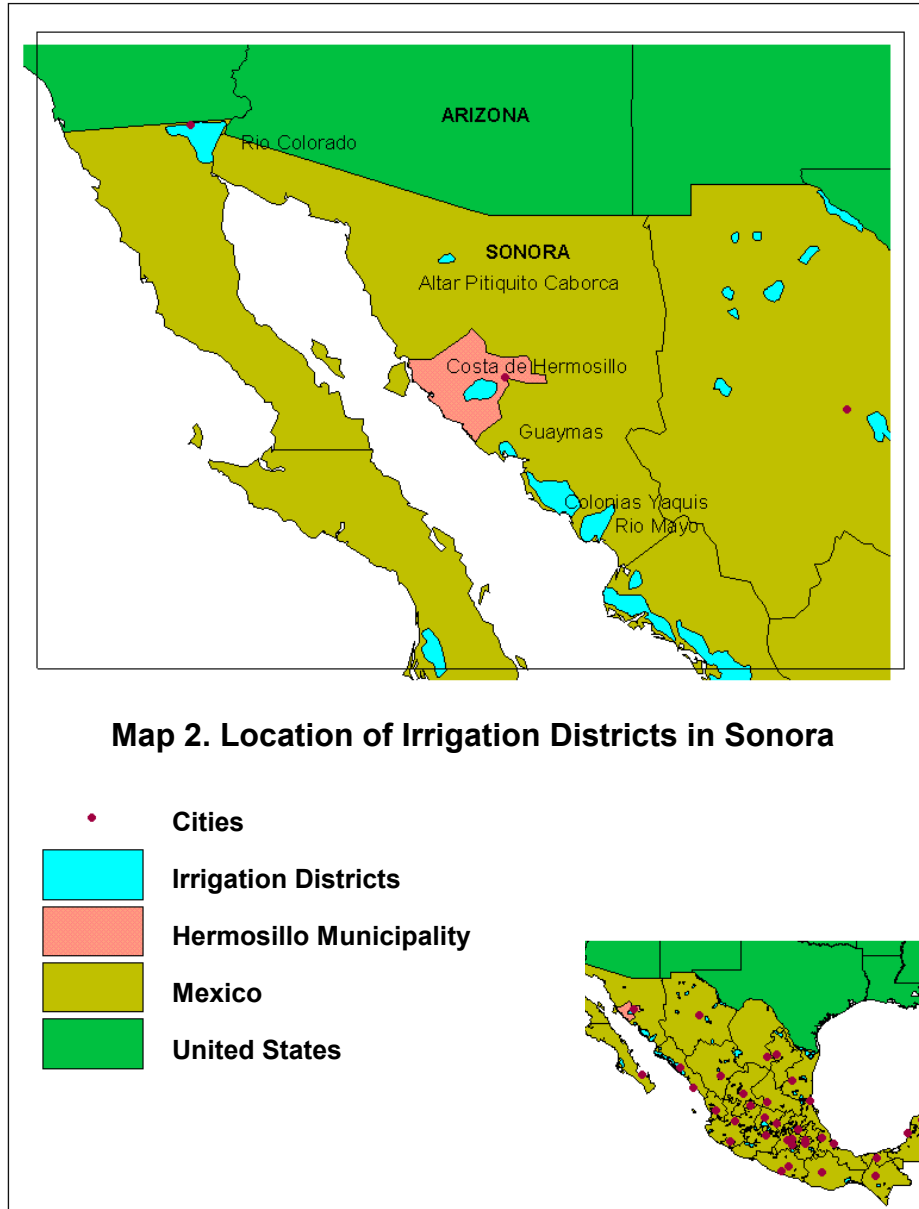
Table 9. Irrigation Districts Operating in the State of Sonora, 2000

Number	Name	State	Thousands of Planted Hectares	Number of Users
014	Colorado River	Baja California and Sonora	208.8	15,182
018	Colonias Yaquis	Sonora	22.8	N/A
037	Altar Pitiquito	Sonora	57.6	3,111
038	Río Mayo	Sonora	97.0	11,563
041	Río Yaqui	Sonora	232.9	22,056
051	Hermosillo Coast	Sonora	66.3	1,957
084	Guaymas	Sonora	16.7	2,179

Source: CNA, Basic Water Compendium for Mexico, January 2001

B. Location of the Hermosillo Coast and Regional Importance

Located in central-western Sonora, the Hermosillo Coast is a semiarid region approximately 200,000 hectares in size (see Map 2). Irrigation District 051 (DDR 051) – which covers an area of 1,738.76 km² – supplies the region from an aquifer located at the edge of the Bacoachi River basin.



Wheat and cotton had traditionally accounted for most of the region's agricultural production. Over the past half decade, however, the production of new crops such as fruits and vegetables has displaced the traditional products of the Hermosillo Coast. Table 10 shows a significant change in land area dedicated to different crops in the Hermosillo Coast irrigation district. These data show the clear drop in wheat and cotton harvesting, which fell from 80% of the land planted to less than 25% in recent years. This decline can also be seen in terms of the land planted, which fell from **270,000** hectares in 1970 to less than 50,000 hectares in 2000.*

At the same time, perennial crop production – including grapes, citrus and pecans – grew to represent more than 40% of the land are planted. Vegetables have also become more important in the last decade, now accounting for more than 10% of the planted area and generating 13% of the daily wages.

These changes in crop patterns are mostly due to different profit margins for different crops. Each crop has an impact in terms of the investment it attracts, the technological innovation it brings, and the jobs it creates. As shown in Table 10, traditional crops have been reduced to half the total surface area in the District, while perennial crops and vegetables already cover 50% of the remaining area. In terms of production value, the traditional crops represent only 13.3% while industrial and table grapes account for two thirds of the total regional value.

*The 270,000 hectares in the first paragraph above appears to be a typo. From further text and the graphic on page 21, it should be 140,000 hectares.

Table 10. Planted Area and Percentage of Participation of the Principal Crops in Irrigation District 051, Hermosillo Coast (1955-2000)

Crop	1955	%	1960	%	1965	%	1970	%	1975	%	1980	%	1985	%	1990	%	1995	%	2000	%
Wheat	51,000	65.0	71,730	62.0	65,000	52.0	77,472	61.0	71,840	61.0	46,244	43.0	42,10	48.0	24,790	36.0	10,800	21.4	10,000	21.1
Cotton	21,000	26.0	18,500	16.0	32,770	26.0	33,000	26.0	14,000	12.0	16,200	15.0	2,467	2.8	475	0.7	3,000	5.9	0	0.0
Vegetables											250	0.2	390	0.4	5,292	7.8	4,250	8.4	5,280	11.1
Table Grapes			40	0.03	65	0.05	400	0.30	1,000	0.8	2,266	2.0	2,219	2.5	4,408	6.5	4,505	9.0	7,934	16.8
Indust. Grapes			230	0.19	285	0.2	1,200	0.9	3,400	3.0	7,134	7.0	8,381	9.6	5,881	8.6	7,310	14.5	4,165	8.8
Citrus	200	0.2	900	0.77	3,100	2.5	4,088	3.0	2,600	2.0	2,200	2.0	2,350	2.7	4,660	6.8	5,500	11.0	5,473	11.6
Pecans					200	0.1	650	0.5	1,500	1.0	2,210	2.0	2,300	2.6	1,928	2.8	1,870	3.7	2,392	5.0
Other	6,300	8.0	24,600	21.2	23,900	19.0	10,112	7.9	23,347	19.8	29,966	28.1	26,401	30.0	20,539	30.2	13,170	26.0	12,037	25.4
Totals	78,500	100	116,00	100	125,320	100	126,92	100	117,687	100	106,47	100	86,608	100	67,973	100	50,405	100	47,281	100

Source: Figures from Irrigation District 051, Hermosillo Coast, and Author Calculations

Table 11 demonstrates that producing 1 kilogram of traditional crops requires 1.2 liters of water, while producing the same amount of new crops uses half as much. Vegetables use 0.55 L / kg, grapes 0.65 L and other perennial crops 0.54 L per kilogram. In terms of production value, each liter of irrigation water generates \$1.94 in traditional crops, \$6.22 in vegetables, \$9.25 in grapes and \$1.79 in other perennials. The effects on labor are equally significant. Traditional crops account for less than 6% of the daily wages generated in the region, while other perennial crops represent 8.8%, vegetables 13.7% and grapes more than 70% of the total number of workers in the region.

Table 11. Cultivation Patterns for Irrigation District 051, Hermosillo Coast (2000)

Crops	Planted Area (Hectares)	%	Production Volume (Tons)	%	Production Value (Thousands of Pesos)	%	Volume of Water Extracted (thousand cubic meters)	%	Daily Wages Generated	%
Traditional	22,037	49.0	91,357	20.7	211,502	13.3	108,993	34.0	158,040	5.4
Vegetables	3,599	7.7	54,192	12.3	185,958	11.7	29,871	9.3	395,890	13.0
Grapes	13,752	29.6	176,124	40.0	1,069,269	67.5	115,516	36.0	2,076,552	72.0
Other Perennials	6,354	13.6	118,080	26.8	116,568	7.3	64,810	20.0	254,160	8.8
Totals	46,412		439,753		1,583,297		319,190		2,884,642	

Traditional Crops: Wheat, Garbanzos, Beans, Corn and Safflower

Vegetables: Lettuce, Sweet Corn, Mexican Succotash, Potatoes, Broccoli, Chiles, Melon, Watermelon, Cauliflower, Kabocha Squash, etc.

Grape: Industrial and Table

Other Perennials: Orange and Pecan

Source: SAGAR, Rural Development District 144 and Author Calculations.

In addition to the use of considerable quantities of water, agricultural production depends on both chemical and biological products. Of the principal insecticides, fungicides, fumigants and herbicides authorized for use on crops in Mexico, about 30 of them are used on the crops destined for export to the U.S., while traditional crops rely on only 13 types of pesticides.ⁱⁱⁱ

It should be noted that use of pesticides on export crops is to some degree determined by the restrictions and regulations imposed by the United States on agricultural products from Mexico. The producers of the Hermosillo Coast now have considerable experience in U.S. regulations, intended to assure compliance with sanitation standards. Therefore, producers are both careful not to use certain substances banned in the U.S., but use sufficient quantities to assure that no pests are present on crops intended for export. Still, there is considerable concern that high amounts of pesticides and herbicides could directly impact both worker health and the aquifer itself.

The Hermosillo Coast has been characterized from its inception by a vast physical infrastructure, a notable degree of technical productivity and high levels of capitalization,

ⁱⁱⁱ Bejarano Gonzalez F. La Espiral del Veneno. RAPAM. México. 2002: and interviews by author.

combined with a capitalistic agrarian structure. These characteristics put the Coast in an advantageous position for the changes brought through the commercial opening and state deregulation since the inception of NAFTA. It has also brought about differing impacts on social actors in the region.

The distribution of groundwater rights is one example of these different impacts.^{iv} Following changes to the National Waters Law, the growers in the Coast became the first private entity to receive underground water concessions through the creation of the *Irrigation District 051 Users' Association of the Hermosillo Coast*. Under the concession, all water rights are controlled by the Association itself. This delegation of powers was a government measure intended to make water use more efficient and make water use more transparent.

However, this greater access to underground hydrologic resources has in actuality led to a concentration of water rights for the largest growers in Sonora, and consequently led to the reconfiguration and segregation of the Coastal property structure. This segregation between large-scale and small-scale growers has gradually forced numerous growers out of the market. On the one hand, large-scale agricultural companies are becoming more and more integrated, with greater access to public resources and an understanding of how to meet international standards. This permits them greater competitiveness within the commercial networks which have been generated through the globalization process.

On the other hand, the "traditional" communal producers, who operate in *colonos* and *ejidos*, have gradually been abandoning their agricultural activity. *Colonos* are agricultural organizations which own individual privately-held property, but farm these fields communally with significant political oversight and government control. *Ejidros*, on the other hand, own and farm their land collectively. The *ejidos* have suffered from a series of historical conflicts and a lack of government support.

The diminishing power of *ejidos* and *colonos* can be seen clearly by the number of wells they control. In 1991, *ejidos* and *colonos* were accessing water from nearly 25 percent of the wells and were using 30 percent of the water (see Table 12). Ten years later, their water use and control of wells has plummeted. For example, of the 100 agricultural *colonías* which operated over a hundred wells a decade ago, only 30 were operating at the end of the 1990s, some of which were actually renting wells, water rights and lands to private growers. None of the four *ejidos* which have water rights and utilized nine wells in 1991 are currently operating.

The shift from *colonos* and *ejidos* to large-scale, privatized farms has been accelerated by the transfer of water rights from these traditional growers to private growers. Although both *colonos* and *ejidatarios* are represented in the Users' Association, each *colono* or *ejido* receives one, collective vote in the forum, even though most *colonias* have at least 100 associates and *ejidos* are often made up of some 40 farmers. While there are *ejidatarios* and *colonos* in the General Assembly of the Users' Association,

^{iv} José Luis Moreno presents a detailed analysis of the concentration of resources among users in the aquifer in *El uso del Agua en un Distrito Agrícola de Riego por Bombeo: El Caso de la Costa de Hermosillo, Sonora, México*. In: Doode Shoko y Emma Paulina Pérez (Comp.) Sociedad, Economía y Cultura Alimentaria. CIAD. 1994.

and even at the Board of Director and Advisory Board level their power is considerably diminished.^v

Table 12. Distribution of Wells and Water Use by Type of Property in the Hermosillo Coast, 1991

Type of Grower and Property	Number of Wells	Percent (%)	Volume of Water Extracted (thousand cubic meters per year)
Private	378	76	284,585
Ejidos	9	2	107,830
Colonos	111	22	17,301
Total	498	100	409,716

Source: : District 144, Hermosillo

The majority of regional agricultural investment now goes toward the cultivation of fruits and vegetables. Consequently, the most influential agricultural organizations in the Coast are those that grow table grapes, citrus, pecans and vegetables. Table 13 shows the available distribution of fruit and vegetable growers in the Hermosillo Coast. According to the table, a total of 8 families control half the production area for table grapes. Three other large families control a fifth of the pecan production in the district. Approximately 15 large families control nearly a third of the productive activity in the Coast, while around 270 small and medium growers try to stay in business with less advantages of economies of scale or government support.

This growing concentration of productive resources has been linked to a specialization of the agrocommercial businesses in export crops. Recent data^{vi} shows the importance of the financial corridor in Sonora-Arizona fruit and vegetable products.

^v León, G. Análisis del Programa de Transferencia de los Distritos de Riego en México: El Caso de Riego 051 – Costa de Hermosillo, Tesis El Colegio de Sonora, 1995.

^{vi} For example, in a recent seminar in Río Rico, Arizona on financing and commercialization of agricultural export products in which bankers, distributors, officials and growers from both states participated, it was estimated that some \$100 million is invested annually in moving fruit and vegetable products from Sonora to Arizona. As reported in Periódico El Imparcial, August 16, 2002.

Table 13. Distribution of Fruit and Vegetable Growers in the Hermosillo Coast, by Crop

CATEGORY	Small	Medium	Large	Very Large	
Table Grape					
Area (Hectares)	140	1,026	1,882	2,975	
Producers	8	18	15	8	
Total Area					6,023
Industrial Grape					
Area (HA)	627	1,747	784	744	
Producers	31	33	9	3	
Total Area					3,902
Citrus					
Area (HA)	1,649	1,949	789	1,086	
Producers	98	31	4	3	
Total Area					5,473
Pecan					
Area (HA)	195	346	1,399	452	
Producers	25	26	5	2	
Total Area					2,392

Source: SAGARPA and Authors' Calculations

The growth in the planted area, production and value of fruit and vegetable crops in the Coast of Hermosillo has outstripped the growth in the other agricultural districts in Sonora in the last two decades (see Table 14).

Table 14. Participation by Agricultural District in Fruit and Vegetable Production in Sonora (1980 – 1998)

	AVERAGE, 1980-1989				AVERAGE, 1990-1998			
	Caborca	Guaymas	Hermosillo	TOTAL	Caborca	Guaymas	Hermosillo	TOTAL
Planted Area	45.0%	11.3%	43.8%	100%	44.7%	7.8%	47.4%	100%
Production	38.3%	10.4%	51.4%	100%	34.2%	8.9%	56.9%	100%
Value	35.7%	10.1%	54.2%	100%	34.7%	6.2%	59.1%	100%

Source: Salazar V y Y. Borbón Costa de Hermosillo: Configuración Hortofrutícola e Intermediarios Comerciales Internacionales. CIAD. 2000.

The dynamism of this export activity has increased the production index and the value of the crops oriented toward international markets (see Table 15). Fruits and vegetables destined for the export markets now represent half of the total production in the district and supply three-fourths of the total value generated in this important agricultural zone in the state.

Table 15. Production in the Hermosillo Coast by Crop Type (1998)

Crop Type	Production		Value (\$)	
	Total,	%	Total	%
Feed	191,588	20.7%	282,323,100	11.1%
Fruits and Vegetables	462,877	49.9%	1,892,853,100	74.8%
Industrial	134,700	14.5%	186,074,100	7.3%
No Feed	137,424	14.8%	168,063,800	6.6%
Others	217	0.0%	2,821,000	0.1%
Total	926,806	100%	2,532,135,100	100%

Source: Salazar V y Y. Borbón Costa de Hermosillo: *Configuración Hortofrutícola e Intermediarios Comerciales Internacionales*. CIAD. 2000.

The new opportunities for fruit and vegetable growers offered by NAFTA has required more than simply technical capacity. It has required a new organization of production which in many cases has required alliances with foreign companies, and, simultaneously, an ability to take advantage of governmental assistance programs. This dual support has allowed growers the ability to meet the demands of international markets.

If these growers have shown important tendencies to integrate the marketing of their product, their insertion in the agrobusiness chains have also shown, like the producers of goods destined for national markets, disadvantages in dealing with the distribution companies. A recent work regarding table grapes makes this clear. Approximately 30 vegetable and fruit distribution companies control the export of these products from Sonora. According to one of the exporting Mexican companies' chief lawyer, the Mexican exporters have suffered the consequences of an unequal commercial relationship, evidenced by their incapacity to reach a common contract which would permit them to overcome financial difficulties, the establishments of insurance, the lack of legal assistance and better access to U.S. regulatory authorities.^{vii}

Recently, the "Producer Foundation" (*la Fundación Produce*^{viii}) began taking the first steps toward helping producers who have not been able to maintain a more equal relationship with the distribution companies, as well as those producers unable to meet the competitive demands of the international market.

^{vii}Newspaper Interview of Richard D. Burris, by Leyla Cattán, Periódico El Imparcial December 11, 12 y 13, 2001.

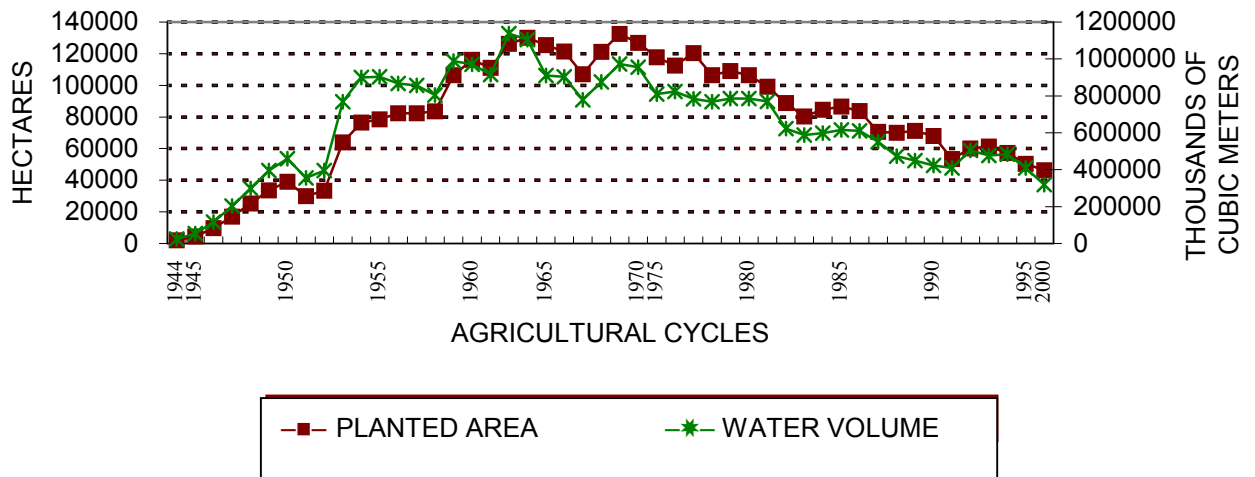
^{viii} A foundation administered by private farmers which establishes research projects and channels resources to producer association priorities.

IV. IMPACT OF NAFTA ON THE HERMOSILLO AQUIFER

Without question, the existence of large water reserves permitted the economic activity described in this report. After fifty years of exploiting these reserves, however, water levels and quality are suffering.

Figure 1 charts the rhythm of water extraction as a function of the registered planted areas in the Hermosillo Coast, since its inception. As the figure shows, agricultural activity grew constantly during the first two decades until peaking near 130,000 hectares of cultivated area. Beginning in the 1970s planted areas fell, leaving the 2000 values below 50,000 hectares. In 2001, there were 498 wells administered by the User's Association of Irrigation District 51.

Figure 1 – Evolution of the Planted Area and Volume of Water Extracted from the Hermosillo Coast Irrigation District (1944-2000)



Source: SARH-DDR

A 1968 study estimated the volume of annual recharge in the aquifers of the district to be 350 million cubic meters. Aquifer rehabilitation programs have been coordinated based on this figure, and these have led to the relocation of some wells, the reduction of water rights per user, changes in crops, modernization of irrigation systems, and even pumping prohibitions in some areas during the 1950s, 60s and 70s. The goal was to balance extraction with the recharge estimation, to minimize the annual average water loss. Despite these measures, concerns remain regarding the increased saltwater intrusion, principally in the area closest to the Coast.^{ix}

Recently, the state government proposed to extract water from the Hermosillo aquifer for the operation of a desalinization plant, with the goal of producing potable water for the state capital. The project included the drilling of numerous wells to extract 3,400 liters per second and to use reverse osmosis to desalinate 2,500 liters per second that would be sent to Hermosillo in a 110 km-long aqueduct. Fierce opposition by the

^{ix} Office of the Governor, Fourth Annual Report of the Government, State of Sonora, 2001, 374.

growers on the Coast forced the modification of the proposal, and the government then proposed to desalinate seawater. This change raised the cost of the project so high that it was rejected by citizen movements in the capital and rejected by the Hermosillo municipal government.

A study done for the failed project, however, provides valuable information on the current state of the only hydrologic reserve that supports economic activity in the Coast. According to the study, excessive water use has forced people to drill deeper for water, which led to increased saltwater intrusion in some parts of the aquifer. Other studies by the same authors also discount the existence of a deeper aquifer supplying the Hermosillo Coast aquifer. Perhaps of more immediate concerns, data show that in 1967, water was pumped from 11 meters *above* sea level, while in 2001, the estimated cone of depression was at 60 meters *below* sea level. Meanwhile, saltwater intrusion has increased to such an extent that currently within a zone some 10 to 15 kilometers wide, the amount of salt has increased from approximately 500 parts per million to between two to eight thousand parts per million.^x It is important to note that the studies to date have focused on the section of the aquifer nearest the coast and do not include other areas of the district that have seen even higher levels of crop production.

Other recent calculations indicate that aquifer recovery levels are well below historical estimates. Various experts have indicated that annual recharge levels are now less than 150 million cubic meters. Based upon the rapidly depleted levels of the aquifer, some studies have suggested that the estimates of water use in the Coast may have been severely understated, perhaps by a factor of two. When added to the poor implementation of water reduction programs, the prospects for sustainability in Hermosillo are challenging. There is consensus among experts that a new, more precise study is needed, incorporating the *dynamic recharge* through the creation of a mathematic, hydrodynamic and hydrodispersive model.

The expulsion of growers from agricultural activity recorded in recent years has led to a reduction in the area set aside for non-competitive crops. As a consequence, many small growers have stopped using their wells, and as a consequence water use has declined overall. At the same time, however, large agricultural farms dedicated to export crops have increased, and to some extent used water that would have been used by the traditional exporters. The active water market in the Coast, linked to the high returns on certain productive sectors, is intensifying the exploitation of hydrologic reserves in certain areas along the Coast. This explains why despite more growers closing their wells, the cone of depression continues to fall and the aquifer suffers from increased salinity levels.

Moreover, the water in the aquifer is now at the center of the dispute between continued agricultural use of the Hermosillo Coast Aquifer and the Municipality of Hermosillo, which hopes to continue to attract foreign investment in large industrial plants, but needs additional water resources to do so. The Municipality of Hermosillo currently supplies 98.22% of its population with potable water, and residents use 97 million cubic meters annually. The water tariff structure in the municipality is such that those who use between 0 and 50 cubic meters per month – mostly domestic residences – account for 92.6% of the total users of water. The prospects of water scarcity and increased tariffs

^x Ibid.

are mobilizing previously dormant social groups against the inefficiencies and inequalities in the administration of water use and rights in the state. For example, a recent citizen movement which arose in opposition to the desalination plant called for repairing the supply network –which potentially loses 45 percent of the water through leaks -- a more precise metering system, and for water conservation measures.

At the same time, the aquifer of the coast – traditionally seen as exclusive property of agricultural interests -- has now become part of the public discussion about water conservation, use and distribution. Not surprisingly, growers have responded with outright rejection of any consideration of industrial or urban use of their water.

V. CONCLUSIONS AND RECOMMENDATIONS

The panorama presented in this report demonstrates the growing divergence between urban and rural interests in the central valleys of Sonora. Where once a flourishing agricultural sector with state support had played a central role in regional development, today the forces of economic liberalization and political modernization are driving political and economic decisions about crop choice, water use and exploitation of natural resources.

The opening of trade areas in the dynamic United States-Mexico border region has increased the pressure that social actors exert on natural resources. In particular, the North American Free Trade Agreement has changed the way that resources are managed, generally at the expense of the diversity and quantity of regional biological resources. The transformations to property and technology on the Hermosillo Coast present serious conflicts in a desert region becoming increasingly concerned with its most strategic resource: water.

A detailed analysis of the structure and production in the District has served to reinforce the need to effectively regulate both the volumes and the types of exploitation of the aquifer. The often-contaminated, always-dwindling water supply in the Hermosillo Coast aquifer indicates the necessity to implement an acquisition and payment program for water rights among the small producers in the District. These growers have expressed interest in exchanging part or all of their water concessions for economic benefits or through the implementation of programs that would modernize their facilities. Such a system might not only guarantee a cheap and secure water source for urban uses, but might also lead to a more effective fiscalization process to control the unchecked exploitation by large companies that has been occurring in the Coast for years.

Nonetheless, such steps would also be open to abuse, becoming a means to subsidize urban and industrial development characterized by further exploitation of this important natural resource, or further social inequity with the water flowing to those most able to pay. Discussions over water use in the Hermosillo Coast region must be tied to a discussion about the type of urban, industrial and agricultural development appropriate for an arid environment. In addition, this discussion about establishing mechanisms for sustainable use of water and possible transfer of agricultural rights to city dwellers must be accompanied by implementation of a real “culture of water” which emphasizes conservation and reuse, as well as waters’ other uses – recreation, aesthetic and

environmental – the source of life for the unique biodiversity of the Sonoran desert region.

Since the enactment of NAFTA, large private agricultural companies have prospered without sufficient concern about the water levels or water quality in the aquifers on which they depend. The dynamic tension between new rural, urban and other economic and social forces will determine future development of the Hermosillo Coast and of the aquifer which bears its name.

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To request copies of the report, entitled, *Acuíferos y Libre Comercio: El Caso de la Costa de Hermosillo*, which is available only in Spanish and includes full citations, contact either of the organizations below. The report is also available on both TCPS's and RFSA's website.

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