

# ECOLOGY AND DEVELOPMENT OF THE BORDER REGION

# ECOLOGIA Y DESARROLLO DE LA REGION FRONTERIZA

STANLEY R. ROSS/Editor

Segunda Reunión de Universidades de México y  
Estados Unidos sobre Estudios Fronterizos

Second Symposium of Mexican and  
United States Universities on Border Studies



ANUIES/PROFMEX  
MEXICO

This volume entitled "Ecology and Development of the Border Region" contains the proceedings of the Second Symposium of Mexican and United States Universities on Border Studies. The need for attention to this subject was recognized at the First Symposium held in La Paz, Baja California Sur, in 1980. The rapid human and economic development in the borderlands made the issue increasingly important, and it was decided to devote the Second Symposium in Austin, Texas, in 1982 to that theme. The participants, with remarkable responsibility, sought to study and anticipate borderlands ecological problems and thereby contribute to the awareness and understanding of those problems.

In four sessions, eight essays and an equal number of commentaries, with each nation represented in each session and in each category of presentation, the Symposium focused on natural resources, air, water, and the social effects of the impact of development on the ecology of the region. The participants recognized the implicit conflict between population growth, urbanization, and economic development which have characterized the region and environmental protection. Transboundary environmental issues loom large in the borderlands and offer important evidence of the interrelationship and interdependency of the border region in the two countries.

The Essay of Honor by Américo Paredes in which he discusses the past and current nature of the *corrido*, not only added a strong cultural element to the Symposium, but also provided an opportunity for the University of Texas at Austin and the National Association of Universities and Institutes of Higher Education (ANUIES) to honor the distinguished folklorist and the "dean" of Mexican-American scholars in the United States.

Este volumen, intitulado "Ecología y Desarrollo de la Región Fronteriza", contiene las memorias de la Segunda Reunión de Universidades de México y Estados Unidos sobre Estudios Fronterizos. En el Primer Simposio efectuado en la Paz, Baja California Sur, en 1980, se reconoció la necesidad de enfocar la atención en la materia. El rápido crecimiento de la población y el desarrollo económico de la zona fronteriza incrementaron la importancia de estos aspectos y se decidió dedicar el Segundo Simposio en Austin, Texas, en 1982, precisamente al tema indicado. Los participantes, con gran responsabilidad, se abocaron a estudiar y anticipar los problemas ecológicos de la región, contribuyendo de esta manera a la comprensión y conciencia de tales problemas.

En cuatro sesiones, ocho ensayos y un número igual de comentarios, los dos países estuvieron representados en cada sesión y categoría del temario, enfocándose el Simposio al estudio de los recursos naturales, del aire, del agua, y de los efectos sociales de la repercusión del desarrollo y la ecología en la región. Los participantes reconocieron el conflicto implícito entre el crecimiento de la población, la urbanización y el desarrollo económico que ha caracterizado a la región y su entorno ambiental. Los problemas de contaminación transfronteriza se observaron indistintamente y amenazadoramente en ambos lados de la frontera y ofrecen una importante evidencia de la interrelación e interdependencia de la región fronteriza de ambos países.

El Ensayo de Honor de Américo Paredes, en el que trata la naturaleza antigua y presente del *corrido*, no sólo introdujo un aspecto cultural significativo en el simposio, sino que también brindó una oportunidad a la Universidad de Texas en Austin y a la Asociación Nacional de Universidades e Institutos de Enseñanza Superior (ANUIES) para honrar al distinguido folclorista y "decano" de los académicos mexicano-americanos en los Estados Unidos.

The Proceedings of the First Symposium held at La Paz, Baja California Sur, in February 1980 appeared under the title **Estudios Fronterizos: Reunión de Universidades de México y Estados Unidos**. México: ANUIES, 1981.

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La Memoria del Primer Simposio celebrado en La Paz, Baja California Sur, en febrero de 1980, fue publicada bajo el título **Estudios Fronterizos: Reunión de Universidades de México y Estados Unidos**. México: ANUIES, 1981.



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**Second Symposium of Mexican and United States  
Universities on Border Studies**

**Segunda Reunión de Universidades de México  
y Estados Unidos sobre Estudios Fronterizos**

**Stanley R. Ross/*editor***

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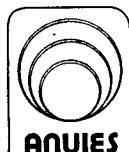
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*Primera edición: México, 1983*

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E INSTITUTOS DE ENSEÑANZA SUPERIOR  
Insurgentes Sur 2133 - 3er. piso  
01000 México, D. F.*

*Impreso en México  
Printed in Mexico*

*Departamento Editorial, ANUIES  
(Cód. Int. 029-83)*

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## INTRODUCTION

STANLEY R. Ross

Preparing this introduction for the volume based on the Symposium of Mexican and United States Universities on Border Studies at the very time that planning is going forward for the third such gathering to be held in Mexico in the fall of 1983 gives one a sense of continuity and of development. From the broad ranging topics of the first gathering at La Paz, Baja California Sur, in 1980, came a recognition of the need to focus on environmental problems arising from human population growth and economic development in the border region. That is the task which was undertaken by the Second Symposium held in Austin, Texas in February 1982.

This series of symposia has enjoyed the endorsement of the Joint Commission on Cultural Cooperation, and both national groups on that body have gone on record as considering these symposia as outstanding achievements in the cultural affairs area. The third conference will examine both the juridical and the non-legal frameworks within which border affairs function. Once again a selected group of scholars from a wide range of universities on both sides of the border will discuss the principal themes which will be commented on and discussed. It is anticipated that the results will include the third volume in this series.

It is true that matters related to the Mexico-United States border for a long time were considered of secondary importance and those who devoted their time, energy, and talent to the region were looked upon with disdain. As Dr. Jorge Bustamante said at the closing gathering of the Austin meeting, the border region "always has been considered the backwash of academia". Border issues, he went on to say, have been relegated to a secondary position and, consequently, there remains much to learn about the region. He spoke of the ignorance which is pervasive in regard to the border region and of the "risks" of such ignorance.<sup>1</sup>

The symposia have the virtue of encouraging good scholars to focus on border problems, of devoting maximum attention to the problems,

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<sup>1</sup> UT NEWS, University of Texas News and Information Service, February 19, 1982.

and of bringing dependable data and informed analysis to the attention of the responsible governmental officials in both nations and the general public. At the Austin meeting there was an impressive array of officials from both Mexico and the United States, including in the latter instance both federal and state officials. Also noteworthy was the preponderance of serious, responsible contributions. Examples of blind advocacy or polemical outbursts were at a minimum. Very much in evidence was a sense of seriousness of purpose and a willingness to listen to other points of view and to accept criticism of one's own work.

At the initial session, moderator Jorge Bustamante observed sadly that almost all Mexican talent in this area was participating in this conference. This not surprising since Mexico, like other developing countries, had for years placed the emphasis on economic development. The Mexicans regarded concern for environmental matters a fad or a luxury in the developed countries which could afford them. In Mexico's case, economic development was viewed as a matter of survival. More recently, beginning in the mid-seventies, Mexico began to pay attention to the environmental consequences of that development and became particularly sensitive of transboundary development which affected the environment on the Mexican side without any economic benefits.

While it is true that the United States is better endowed in terms of quantity in this important area, the purely quantitative approach is deceptive because of the relatively high proportion of "advocates" who are dedicated to cause, but are not interested in seriously studying the problems and possible alternative ways of dealing with those problems. The participants in this symposium have done much to contribute to both an awareness and understanding of the ecological problems in the border region. They have carried out the declared purpose to study and anticipate borderlands ecological problems. Through their essays, commentaries, and discussion, they have called attention to the reality and future development of these ecological questions in the border region.

Perhaps the most upbeat part of the symposium was the session on natural resources. The very selectivity of the presentations was the first suggestion of how multifaceted and complex was the topic of "Ecology and Development" in the frontier regions of the Mexico-United States border. Professor Johnson and his colleagues focus on new possibilities in the field of agriculture through the use of wild plants in arid and semi-arid reaches of the region. In his essay, Professor Servín-Massieu describes the actual resource situation in terms of ecological systems and fauna in five principal zones defined geologically and ecologically.

Very much aware of the impact of development in terms of population and economic growth, Professor Servín-Massieu nevertheless explicitly eschews the "rhetoric of catastrophe" and rejects the extremist views of both the conservationists and the consumers of the environment.

Like so many other participants in the symposium, he calls for additional study, particularly systematic interdisciplinary studies of the possible consequences of environmental deterioration.

In the section on "AIR", the two essays and commentaries are very well synthesized by the moderator, Professor Richard Bath, who observed that "...we do have very grave problems of air pollution along the United States-Mexico border". And, he added, "those problems are severe in the San Diego-Tijuana and El Paso-Ciudad Juárez metropolitan areas. However, the air pollution problem is not limited to the larger metropolitan areas. Smaller communities, like "ambos" Nogales, have problems as well". This is not a new concern, Professor Bath noted, since there has been almost a decade of activities related to air pollution which has become an "on-going focus of interest of the academic community".

Some feeling for the complicated juridical problems involved emerged from the discussion at this session. A member of the audience focused on the responsibility that results from contamination which in international law is called objective responsibility for risk created. While for other types of responsibility custom is recognized, this type of responsibility needs to be explicitly expressed in a treaty or convention. In the absence of such a treaty between Mexico and the United States, it is difficult to fix responsibility under public international law. What happens is recourse to private international law and here the problem of conflict of laws arises.

The individual raising this issue spoke critically of the "exorbitant competence" claimed by the United States. The United States considers its laws applicable and its courts competent for whatever problems arise anywhere. For example, in the case of contamination attributed to ASARCO and claimed to have caused health problems in Ciudad Juárez, the case is pending before a United States court in El Paso. In the case of the Ixtoc spill, damage occurred, the contrary process prevailed with the suit filed where the in responding, Professor Bath agreed that there was a question of liability across transnational boundaries. He referred to arbitration regarding a Canadian smelter and damage to cattle in the state of Washington. He added that under 1970 clean air legislation, Mexican citizens have the right of access to United States courts in cases related to air contamination. He added that while now recognizing that immediate results cannot be expected in this area, progress is being made. Specifically he cited: a pending court case that could well be precedent setting; that some economists are beginning to include degradation and pollution of the environment in the concept of economic growth and the political awakening along the border has produced opposition to the continuation of the variance for ASARCO on the emission of sulphur oxide.

If economists in the developed countries have been slow to include environmental problems in the concept of economic growth, the economists

of developing countries have tended to focus on economic development downplaying the environmental consequences. However, Dr. Bath viewed as real progress that announcement by a group of top Latin American economists of ECLA in 1980 that they had had their heads in the sand with respect to development economics, developmental patterns and the environment. They had reversed their view of the role of the environment in development and they are now concerned about it.

During the past several years, transboundary water resources —so vital to both human and economic development— has been recognized as a matter of binational concern affecting the quality of life in a variety of ways and posing significant juridical and social issues that have a potential for international confrontation. Water was a major focus of meetings at South Padre Island and Querétaro held under the auspices of the Institute for Juridical Research (Instituto de Investigaciones Jurídicas) of the National Autonomous University of Mexico, the Institute of Natural Resources at the University of New Mexico, and the Mexico-United States Border Research Program at the University of Texas at Austin.<sup>2</sup>

Water was defined as one of the major preoccupations of the academics gathered at La Paz for the first symposium. Impressed by the depth and dimensions of the issue and its potential for increased difficulties in the future, the organizers of the second symposium gave the topic high priority. Water looms large as an essential ingredient and as a potential limiting factor. Dean Ernest Gloyna of the College of Engineering at the University of Texas at Austin declared, "the success of the Texas economy depends on water". However, he warned that "long-range development of water resources have not kept up with the state's needs".<sup>3</sup>

In a *New York Times* article discussing the slowing of the Texas economy, Professor Joe B. Frantz, historian of the University of Texas at Austin, is quoted as saying, "My own theory is that [the Texas economy] will come back—if we don't run out of water."<sup>4</sup> In fact, West Texas is running out of water, and the High Plains Study Council, chaired by former Governor William Clements of Texas, reported in December to the Secretary of Commerce to the effect that agriculture in Texas

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<sup>2</sup> The results of those conferences have been published in a double issue of the *Journal of Natural Resources*, Vol. 22: N° 4 (Oct. 1982), 729-1179. The material later will appear in book form as a joint undertaking of the Institute for Juridical Studies (UNAM), the Mexico-United States Border Research Program (University of Texas at Austin) and the Natural Resources Center (University of New Mexico School of Law).

<sup>3</sup> UT News, University of Texas News and Information Service, February 25, 1982.

<sup>4</sup> ROBERT REINHOLD, "Recession is Managing to Cut Texas Down to Size", *New York Times*, December 26, 1982.

and other High Plains states will not survive without the importation of water into the region.<sup>5</sup>

Professor Utton, in his essay, focuses attention on three major factors: population growth, increased economic activity, and a finite supply of water resources all occurring within the context of an international frontier zone. He called for arrangements for equitable distribution of ground water as has been done with the surface waters. Professor Vargas complained that environmental problems do not have high priority with either government and that this changes only when the damage affects a significant area over an extended period of time.

In the discussion that followed the commentaries by Professor Gerard Rohlrich and Ing. Joaquín Bustamante, a member of the audience applauded the concept of equity between Mexico and the United States regarding water resources, and raised the question of equity between Texas and New Mexico. The question underscored the reality of having four state jurisdictions, each with its own legal water arrangements. Pending in a United States District Court in Albuquerque, New Mexico, is a case in which El Paso is challenging a New Mexico law banning the export of ground water to other states. Since the water involved also lies under Mexico, that country and particularly those in Ciudad Juárez are very interested observers to the Texas-New Mexico legal battle.

New Mexico is fighting the suit in what its ranchers and farmers have labeled "the great Texas water grab".<sup>6</sup> The individual who raised this matter added that there is a saying in New Mexico and proceeded to give an adaptation of an oft-quoted Mexican saying from the nineteenth century: "Pobrecito Nuevo México, tan lejos de Dios, tan cerca de ustedes (los texanos)." Translated the phrase says, "Alas, poor little New Mexico, so far from God, so close to the Texans".\*

There can be no question that transboundary environmental issues loom large in the borderlands of Mexico and the United States. It is one more evidence of the interrelationship and the interdependency of the border regions in the two countries. Population growth, urbanization, and economic development have characterized the region and demon-

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<sup>5</sup> High Plains Study Council, Economic Development Administration, "A Summary of Results of the Ogallala Aquifer Regional Study, with Recommendations to the Secretary of Commerce and Congress", Dec. 13, 1982, 60 pp.

<sup>6</sup> "Thirsty Juárez Awaits U.S. Verdict", *Austin American-Statesman*, November 29, 1982, p. B8.

\* On January 17, 1983, the United States District Court in El Paso nullified the New Mexico state law banning the transporting of groundwater to Texas, ruling that El Paso may import up to 296,000 acre-feet (or approximately 300 billion gallons) of water a year from neighboring New Mexico. *Austin American-Statesman*, January 20, 1983, p. B6. [Editor's Note].

strated conflicts implicit "between the objectives of economic development and environmental protection".<sup>7</sup> The pollution levels of both air and water have increased sharply on both sides of the border underscoring the need for continuing measures to rectify the situation and prevent its worsening.

While the social consequences of all of this were touched upon directly or indirectly in all the sessions, it was the final one which focused directly on this important aspect of the topic "Ecology and Development in the Border Region". Professor Rolando Hinojosa Smith, in his moderator's synthesis, does a superb job of summarizing and highlighting the presentation by Professors Restrepo and Downing on the one hand and that by Professor Weaver on the other. Similarly, he gives an excellent analysis of the commentaries by Professors García Moreno and McGarity.

Before the general discussion began, Professor Downing blasted those who continue to raise "this damn population question". He argued that the rate of growth on the Mexican side has stabilized and that global projections looking ahead twenty and forty years are "absolute nonsense". It is an open question whether this point of view was persuasive for the majority of the scholars present. For example, Joseph Nalven observed that growth still is higher in Tijuana than it is in San Diego, even though it might be stabilizing. The same might be said comparing Ciudad Juárez and El Paso.

Professor Servín-Massieu made what he described as "a small comment in defense of ecology with a biologist's optics". He expressed his concern about the repeated tendency to extrapolate from ecology to environmental contamination. "Ecology... includes not only contamination, but also the dynamic of populations, the specific relations among living organisms, and —of course— evolution." He hoped that there would not be acceptance of the image that ecology is nothing more than contamination.

Expressing concern that theorizing about the border was somewhat introspective, Professor Hans Baade of the University of Texas Law School noted that the eminent English economic historian, Sydney Pollard, had concluded that political boundaries in Europe have not really had much influence on economic development one way or the other. Most notably tariff boundaries have led to twin cities. However, Professor Baade does not believe that the boundary between Mexico and the United States can be looked at in the same way. In explanation, he mentions only three of the elements which should be kept in mind.

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<sup>7</sup> NILES HANSEN, "Transboundary Environmental Issues in the United States-Mexico Borderlands", *The Southwestern Review*, Vol. 2: № 1 (Winter 1982), p. 61.

The first of these is the historical ingredient represented by the slogan in Mexico during the seventies of the 19th Century that between strength and weakness there must be a desert. This greatly influenced the development and location of Mexican industries and most specifically the construction of the railroads. Secondly, there is the 100-kilometer rule in the Constitution of 1917 which restricts foreign ownership of property within the cited distance from the border or the coast. This has led to certain developments along the border which would have been quite different if that rule did not exist. Thirdly, Professor Baade noted the development of the second tier of Mexican states or of the second zone of the first tier of Mexican states.

Before this session concluded, a member of the audience took up the restrictions of Article 27 of the Constitution prohibiting foreigners to hold immovable property within a certain distance of the frontier or the coast. Recognizing that there are many subjects which had not and could not be covered in this symposium, he refers specifically to the matter of the trust (*fideicomiso*) in the frontier zone. This has meant that there has been found a legal mechanism to make it possible for foreigners to have immovable property in the restricted zone. He concluded that it is no accident that the border zone is full of the assembly plants (*maquiladoras*), 80% of which are in the hands of subsidiaries of transnational United States enterprises.

To add a cultural dimension to a conference which was heavily weighted on the physical and social sciences side, it was decided to invite the distinguished folklorist, Professor Américo Paredes, to give a dinner address which appears in this volume as the Essay of Honor. The outstanding Mexican-American scholar discussed "The Corrido: Yesterday and Today" with musical illustrations by the Mariachi Américo Paredes de Tejastitlán. However, there was a hidden agenda. The University of Texas at Austin wished to use the occasion to honor Professor Paredes for his long (twenty-six years) and outstanding service to the institution. When our Mexican colleagues learned of this, they insisted that they, too, have an opportunity to honor Américo.

Teacher, writer, poet and folklorist, Américo Paredes is considered the "dean of Mexican-American scholars". He is, as I said when I introduced him, truly a man —and a colleague— for all seasons. A former student and colleague described "his scholarship is learned and prolific, his teaching humanistic and caring".<sup>8</sup> He has fought to correct stereotypes of Mexican Americans. He once said of himself, "I have not lost my sense of identity as a *Mexicano*. Obviously, I am acculturated, but I wouldn't say I am assimilated; when you assimilate, you

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<sup>8</sup> REY GUEVARA-VÁZQUEZ, "Maverick scholar fighting to correct history's prejudice", *Austin American-Statesman*, February 7, 1982, p. C1.

lose total identity. That is a tough problem that is faced by young Chicanos."<sup>9</sup> He encourages young Mexican Americans to drop the gun, pick up a pen and work within the system. A precursor of the Chicano movement, he is its strong ally.

Dr. Gerhard J. Fonken, Vice President for Academic Affairs and Research, presented Professor Paredes with a plaque with a wood backing shaped like a book. It bears a likeness of the honoree with the following citation: The University of Texas at Austin Honors Américo Paredes, Ashbel Smith Professor, For a Quarter of a Century of Contributions to Mexican and Mexican-American Culture. The plaque is dated February, 1982 and is signed by President Peter T. Flawn and bears the University seal. Mrs. Paredes was presented with the artist's drawing based on a photograph from which the etching on the plaque was made by Vice President and Dean of Graduate Studies, William S. Livingston.

On behalf of the Mexicans, Dr. Rafael Velasco Fernández, Executive Secretary General of ANUIES, presented a handsome plaque bearing the seal of ANUIES on top. Below is the following citation: The National Association of Universities and Institutes of Higher Education of the Mexican Republic Presents this Diploma to Professor Américo Paredes in Recognition of His Efforts On Behalf of the Diffusion of Mexican Culture in the United States of America, Realized During a Long and Brilliant Professional Life. Dated 18 February 1982 in México, D. F. and signed by Dr. Rafael Velasco Fernández, Executive Secretary General.

In the text that follows, the essays and commentaries appear in the language in which each was presented. Following each moderator's synthesis, there is a brief summary in the opposite language. Similarly, this introduction will be followed by a summary in Spanish.

I want to take this opportunity to express my appreciation to the two sponsoring organizations, ANUIES and PROFMEX, and to the United States International Communications Agency for a grant which facilitated participation by United States' scholars and the hosting of the symposium by the University of Texas at Austin.

Austin, Texas

February 1, 1983

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<sup>9</sup> *Ibid.*, p. C14.

## RESUMEN EN ESPAÑOL

Preparar la introducción para este volumen, que corresponde al segundo simposio de las universidades de México y Estados Unidos sobre estudios fronterizos, al mismo tiempo que se está planeando el tercero, que se realizará en el otoño de 1983, le da a uno la idea de continuidad y desarrollo. Así, después de la amplia gama de temas tratados en la reunión de La Paz, Baja California Sur, en 1980, se pasó a la atención de problemas más específicos como los del medio ambiente en Austin, Texas, en 1982. Para seguir en la línea de atender un tema esencial en cada ocasión, el tercer encuentro se dedicará a estudiar los marcos tanto de derecho como de hecho en que se dan ciertos asuntos fronterizos.

La reunión efectuada en la Universidad de Texas, en Austin, se distinguió por la asistencia de importantes funcionarios públicos de México y Estados Unidos, así como de participantes calificados y responsables. No obstante las muy valiosas aportaciones que los especialistas hicieron al conocimiento de los problemas del medio ambiente en la frontera, casi todos ellos coincidieron en demandar estudios adicionales, especialmente los que atiendan de manera sistemática e interdisciplinaria las posibles consecuencias del deterioro del ambiente.

La información, los análisis y la discusión de los temas no se restringieron a lo presentado por los ponentes y conferencistas del programa: la audiencia participó también con entusiasmo, rigor y seriedad. Precisamente una intervención del público hizo destacar lo necesario que es un tratado o una convención entre México y Estados Unidos, que fije explícitamente las responsabilidades en materia de contaminación en la frontera.

Un comentario hecho por el Dr. Servín-Massieu podría sintetizar el espíritu de la reunión en Austin, desde la selección de los temas hasta el último análisis: "La ecología se ocupa de muchas cosas además de la contaminación del ambiente e incluye en sus estudios a la dinámica de las poblaciones, las relaciones específicas entre los organismos vivientes y, por supuesto, la evolución." Por ello, pese a que se trabajó con temas tan específicos como "agua" y "aire", siempre estuvo presente la preocupación por las consecuencias sociales de los problemas de la ecología y el desarrollo de la población en la frontera.

**xxii • Resumen en Español**

El programa científico de la reunión en Austin se enriqueció con un colofón, durante la cena de clausura, de carácter humanista y que consistió en una conferencia, "El corrido: ayer y hoy", a cargo del Dr. Américo Paredes. Este ensayo aparece en la memoria con el carácter de "ponencia de honor", como un homenaje a la tarea realizada durante más de 25 años por el académico mexicano-estadounidense en la Universidad de Texas.

STANLEY R. Ross.

# ECOLOGY AND DEVELOPMENT OF THE BORDER REGION

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# ECOLOGIA Y DESARROLLO DE LA REGION FRONTERIZA



*HISTORICAL ANTECEDENTS*

I

ANTECEDENTES HISTÓRICOS



## THE BI-NATIONAL SYMPOSIA IN HISTORICAL PERSPECTIVE

MICHAEL C. MEYER

Cultural relations between the United States and Mexico are as old as are the two countries, but prior to the late 1930's, they were conducted almost entirely under private auspices. Cultural relations fostered by the respective governments are of more recent vintage. In 1937, the United States and Mexico, along with fifteen other American nations, signed the Convention for the Promotion of Inter-American Cultural Relations. Of the seventeen signatories to that Convention, Mexico and the United States unquestionably have been the most responsive in implementing both its design and its spirit.

In 1948, the two countries established a Joint Commission on Cultural Co-operation which has met periodically since that time. Under its auspices, scholars, artists, creative writers, and musicians visited each other's country, lectured, performed, arranged exhibits, concerts, dramatical productions and exchanged publications. Not only were new personal and professional relationships forged, but the cultural accomplishments of each country were brought to the public consciousness of the other.

During the last few years, the activities fostered at the initiative of the Joint Commission have been especially extensive. Drawing upon the combined resources of the National Endowment for the Humanities, the National Endowment for the Arts, and the International Communication Agency in the United States, and the Instituto Nacional de Bellas Artes, FONAPAS, ANUIES, the Secretaría de Educación Pública and the Secretaría de Relaciones Exteriores in Mexico, a wide variety of bi-national cultural activities have been carried out in both countries. The Mexico Today Program, the Eugene O'Neill festival in Mexico City and the Fulbright Border Lecture Program are simply a few recent examples of representative programs.

Another of these activities was the First Conference of Mexican and United States Universities on Border Studies, a meeting held in La Paz, Baja California on February 28 and 29, 1980. That conference coordinated by the University of Arizona and ANUIES, was a general one treating

#### **4 • Historical Antecedents**

such themes as the Idea of the Border in National Consciousness, Natural Resources and Border Development, Production and Border Industry, Economic Inter-Change, Migration and Border Culture. The social scientists, natural scientists and humanists who participated in that conference were enthusiastic with its results, including the publication of the proceedings by ANUIES under the title, *Estudios Fronterizos*.<sup>1</sup> The Joint Commission also judged that meeting to be a success as both the United States and Mexican delegations reported favorably on it. That positive endorsement paved the way for the funding of this Second Binational Symposium on Border Studies, this one on a much more restricted theme: "Ecology and Development of the Border Region."

Because of cultural differences and different approaches to problem solving, bi-national planning requires a special commitment and a special set of sensitivities; but those of us on the organizing committee of the bi-national symposia agree that the extra effort expended on both parts yields a unique kind of dividend.

Our Mexican colleagues at ANUIES and the academic representatives who they have designated to represent Mexican higher education have been splendid in their cooperation. The type of working relationship that has been established has contributed in a major way to the early successes the symposia have enjoyed.

Having served as coordinator of the United States delegation to the First Conference, I am pleased to have been relieved of all onerous responsibilities at this one. I am here simply to derive pleasure and profit from it, to renew my friendships with my United States and Mexican colleagues, to thank Professor Stanley Ross and his associates at the University of Texas for the superb job of organization and to join Dr. Rafael Velasco, of ANUIES, in wishing you success as you embark upon your endeavors.

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<sup>1</sup> *Estudios Fronterizos: Reunión de Universidades de México y Estados Unidos (Ponencias y Comentarios)*, México, ANUIES, 1981. The volume may be purchased from the Departamento Editorial, Asociación Nacional de Universidades e Institutos de Enseñanza Superior, Insurgentes Sur 2133, 3er. piso, México 20, D. F., or from the Latin American Area Center, University of Arizona, Tucson, Arizona, 85721.

## EL SIMPOSIO BINACIONAL EN PERSPECTIVA HISTÓRICA

RAFAEL VELASCO FERNÁNDEZ

En el año de 1979, la Asociación Nacional de Universidades e Institutos de Enseñanza Superior propuso a la Comisión Mixta Cultural de México y los Estados Unidos de América la realización de una reunión académica de nivel universitario para conocer, analizar y difundir los trabajos más recientes de profesores e investigadores mexicanos y norteamericanos en materia de asuntos fronterizos que atañen a nuestros países.

Al hacer la proposición, la asociación consideró que era necesario impulsar en los medios universitarios y tecnológicos de las dos naciones la identificación y definición de los problemas de la región fronteriza, con la finalidad de analizarlos y descubrir la naturaleza de los fenómenos que implican, sus relaciones y sus consecuencias en las sociedades de cada país.

La Comisión Mixta Cultural aceptó la idea de la asociación, iniciándose los trabajos que culminaron con la realización de la "Reunión de Universidades de México y Estados Unidos de América" en la ciudad de La Paz, B. C. S. en febrero de 1980. En esa ocasión, la sede fue la Universidad Autónoma de Baja California Sur.

Considerando las partes el éxito académico de la reunión de La Paz, inmediatamente se procedió a iniciar la organización de la segunda reunión, ahora teniendo como sede una universidad norteamericana, escogiéndose la Universidad de Texas en Austin. Entretanto y como resultado del encuentro en la península de California, la asociación publicó las memorias en la obra *Estudios Fronterizos* en junio de 1981.

El enfoque dual y la confrontación natural de los puntos de vista sobre los temas del temario recogidos en dicha publicación, constituyen una valiosa aportación al conocimiento actual de la situación para los interesados en la política y la cultura, así como también para los estudiantes de los temas económicos, científicos y tecnológicos de nuestros países.

## **6 • Antecedentes Históricos**

En este contexto, se inicia la segunda reunión para tratar otros planteamientos, surgidos recientemente o ya ancestrales, en una búsqueda continua de caminos de expresión para una población que en ambos lados de la frontera emerge con sus anhelos, necesidades y carencias.

Deseamos expresar nuestro agradecimiento a la Universidad de Texas en Austin, a su presidente, el Dr. Peter Flawn, y al doctor Stanley Ross, por su hospitalidad y acogida para esta importante reunión. Particularmente aprecio el entusiasmo, el profesionalismo, el espíritu incansable y el interés por nuestro país del doctor Stanley Ross, coordinador académico del evento por las universidades norteamericanas, quien sobreponiéndose a un delicado estado de salud, desarrolló un gran esfuerzo en la organización de esta reunión.

Igualmente quiero destacar la presencia del Lic. Eliseo Mendoza Berrueto, Subsecretario de Educación Superior e Investigación Científica de México, quien ha hecho un esfuerzo que mucho le agradecemos para acompañarnos. Sabemos del exceso de trabajo que en estos días le asedia, relacionados con las responsabilidades inherentes a su alto cargo y por ello nos satisface mucho su buena voluntad de estar con nosotros en esta ceremonia inaugural.

Dado que sin duda campearán en nuestro encuentro este espíritu de trabajo y la buena voluntad, respaldados por el alto nivel académico de los participantes, estoy convencido de que se alcanzarán los objetivos que nos hemos fijado.

*NATURAL RESOURCES*

II

RECURSOS NATURALES



# NATURAL RESOURCES: THE POTENTIAL FOR DEVELOPMENT IN BORDER REGIONS OF MEXICO AND THE UNITED STATES

JACK D. JOHNSON, CHARLES F. HUTCHINSON,  
AND BARBARA S. HUTCHINSON

## INTRODUCTION

In this paper we have identified possible opportunities for new agricultural development in the United States-Mexico border region. The focus will be on: *a)* the exploitation of new or traditional, arid-adapted crops; and *b)* the identification of potentially exploitable lands that have been heretofore, little or under used or that have recently declined in economic productivity.

Since the intent of this symposium is to identify problems, issues and areas for research, this discussion will be broad. We begin by arbitrarily defining the border region and identifying areas within the region that may offer opportunities for new agricultural development. This is followed by a discussion of some potential new crops that may prove to be economically important within the region in the coming years and we offer some ideas on how those plants might be cultivated. The types of problems that must be overcome to bring new crops into production is then outlined. Appendix A lists the United States and Mexican institutions that are involved in new crop research. Appendix B lists promising plants and references recent research.

We discuss what may be physically and economically possible. There is no attempt to address the equally broad and important social topics that will ultimately determine the success of any development project.

## CHARACTERISTICS OF THE BORDER REGION

The border region of the United States and Mexico is topographically complex. It is traversed by the three major mountain ranges that dominate northern Mexico. In the west, the Peninsular Range, which comprises

## 10 • Natural Resources

the spine of the Baja California Peninsula, extends almost 200 km. into California and reaches an elevation of more than 1,500 m. The Colorado River has built a delta in a large structural trough below the steep eastern escarpment of that range. The delta extends across the depression and separates the Gulf of California and the Salton Sea. The agricultural region of the Imperial and Mexicali valleys is located on this delta.

To the east of the Colorado River is the southern part of the basin and range province of western North America, a region generally called the Sonoran Desert. It is marked by isolated northwest-southeast trending fault block mountains separated by wide valleys. The elevation increases to the east; it culminates in the complex of high mountain ranges in southeastern Arizona, northeastern Sonora, and northwestern Chihuahua that mark the northern extent of the Sierra Madre Occidental.

Below this highland, stretching to the Big Bend region of Texas, is the relatively high basin of the Chihuahuan Desert. It is broken by scattered ranges, similar in form to the basin and range province but more complex. Along the eastern boundary of this area, the Rio Grande flows in a general northwest-southeast direction. Midway in its traverse natural scientists and humanists who participated in that conference of the region, the Rio Grande turns to the northeast to pass between the Sierra Madre Oriental of Coahuila and the Santiago Mountains of Texas. East of the mountains the Rio Grande turns to the southeast, joins the Pecos River, and crosses the coastal plain to the Gulf of Mexico.

Almost the entire border region can be classified as dry according to the Koeppen climatic classification system. Exceptions occur in the mountain ranges of the Californias, the ranges associated with the Sierra Madre Occidental, and along the coast of the Gulf of Mexico. Annual precipitation exceeds 500 mm. only near the Gulf of Mexico. The average annual precipitation for the region is less than 300 mm. Within the region are some of the driest areas in North America, including the Colorado Desert in the Californias and the Gran Desierto of Sonora.

Vegetation of the region is arranged in elevational zones that reflect the general increase in precipitation with elevation. In the lowest and driest parts of the region, the dominant vegetation is desert scrub. Both the Sonoran and Chihuahuan deserts are dominated by creosote bush (*Larrea* spp.). In low-lying parts that are affected by salt accumulations, large areas may be dominated by salt bush (*Atriplex* spp.). Increases in elevation are accompanied by increases in plant diversity. In the western part of the region, leguminous trees (e.g. *Prosopis* spp. and *Cercidium* spp.) and columnar cacti (e.g. *Cereus* spp.) are typical of the diverse desert scrub vegetation that is found above the 500 m. contour. In the eastern part of the region, mesquite (*Prosopis* spp.) and juniper (*Juniperus* spp.) also are represented but on limestone soils they are often joined by yuccas and a variety of agaves.

Intermingled with and extending above this diverse desert scrub is semidesert grassland. Much of this vegetation zone has been invaded recently by shrub species from adjacent zones. At still higher elevations (generally greater than 1,200 m.), the grassland grades into an oak or pinyon-juniper woodland. Coniferous forests occur in the highest reaches of the Peninsular and Sierra Madre Occidental ranges.

Surface water throughout the region is scarce. Although there are a number of relatively small perennial or recently perennial streams along the border, their significance is local; they have permitted the development of small oasis agriculture, supported by either perennial streamflow or the relatively shallow water associated with the stream. The Colorado River in the west and the Rio Grande in the east contribute the bulk of available water for agricultural development in the region.

Groundwater is localized and is highly variable in quality. Interior drainage basins in the Sonoran and Chihuahuan deserts have captured and stored a considerable amount of water; however, the water may contain a high percentage of dissolved salts.

Historically, man has exploited these scarce resources in predictable ways. Grazing is undoubtedly the most important land use, in terms of area. Being the most effective use of scarce vegetative resources, grazing is practiced throughout the region. In contrast, commercial timber production in the region is so restricted that it is not considered when the region is viewed as a whole.

In the past, the most dramatic development in the region has been the large scale development of irrigated agriculture in the Imperial-Mexicali and Rio Grande valleys. The economic impact on both countries has been profound and the continued vitality of the region is closely tied to their persistence.

More recently the border region has been a population magnet in both countries. The migration to the "Sunbelt" by businesses and retirees has created rapidly growing urban populations in the United States Southwest. In Mexico, the perceived opportunities for employment along the border have led to a similar increase in urban population.

#### **PROBLEM STATEMENT**

For the most part, the border region shared by the United States and Mexico is characterized by relatively low economic productivity. The notable exceptions are the agricultural oases of the Imperial-Mexicali and Rio Grande valleys, and a number of small basins that support groundwater irrigation. Both countries have experienced population migrations to the border region, and all human activities that consume

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water (including urban, agricultural, industrial and mining uses) are competing for a dwindling supply of water that is decreasing in quality.

As a highly water-consumptive activity, agriculture now must resist the pressure of the more intensive economic activities. Agriculture, as a result, has suffered a decline in some parts of the region; most notably in the Mexicali, Santa Cruz and Pecos valleys. However, there is interest on both sides of the border to enhance or at least to stabilize agricultural productivity in the region. Clearly, water will be the principal constraint on agricultural development. Hence, there are three ways in which development could proceed: *a*) use less water to produce a crop; *b*) grow more valuable crops; or *c*) exploit water supplies for which there now is little demand.

The problem that faces the region, which we now address, is to identify lands in the region that might be used for new crop production.

### LAND RESOURCES

We have described water as the primary limiting factor in maintaining agricultural productivity. Several potentially high value crops either use water more efficiently than present crops or exploit previously unused water sources. Given these options, there are several types of land in the region that might be available to produce these new crops, e.g., active irrigated land, retired or idle irrigated land, land irrigated with saline waters, marginal lands, and lands that would support harvest of wild crops.

The boundary of our study area (Figure 1) is defined by the county and municipio boundaries that lie along the United States-Mexico border. The boundary may be objectionable to some because it does not conform to the boundaries of recognized ecological units. However, most data that describe economic and agricultural conditions are reported by county or municipio. Thus, if a more coherent regional boundary were used much detail would be lost. The study area encompasses an area of more than 43 million ha. (25 million ha. in the United States; 18 million ha. in Mexico).

Estimates of total land areas that might be available for new crop production are described below. Since there are no consistent information sources, our estimates are derived from a variety of sources.

A. *Irrigated land (active)*. If crops are developed that are more water efficient and/or of higher value than those presently grown, and if we assume that farmers are prudent, these new crops will be planted on lands that are currently farmed. Within the region, there are now approximately 3 million ha. of irrigated cropland. (There is an additional .4 million ha. of rainfed agriculture in Texas.) The distribution of

these lands is shown in Figure 2. This represents a maximum estimate of area that has been irrigated during the past 15 years; the actual area that is currently irrigated will be considerably less.

B. *Irrigated land (idle/retired).* As a result of rising irrigation costs, decreasing water quality, and increasing soil salinity, the amount of irrigated land has declined. With the advent of new crops, it is possible that idle or retired lands might be brought into profitable production. Since these lands represent a considerable investment of capital in water delivery and drainage systems, and since they are incorporated into a larger infrastructure, it would be relatively easy and highly desirable to bring them back into production.

To the best of our knowledge, there are no comprehensive figures that describe the amount of land that has been withdrawn from production during the past 10 years. Thus, it is difficult to develop an estimate of the land resource that might be available. Rather than attempt to develop an estimate for the region as a whole, based on highly speculative data, we will examine the situation only in Arizona, an area we feel to be representative of the region.

Essentially all agriculture in Arizona is irrigated, drawing both on ground and surface waters. During the past 25 years the land area devoted to crops within the state has fluctuated around .5 million ha. In 1977, the area devoted to crops reached a high of almost .5 million ha. Since then, however, there has been a steady decline in usage. We now estimate that nearly 20 percent of all Arizona cropland is idle. In 1980, more than 50,000 ha. of farmland in Pinal County alone were out of production (Foster, Rawles and Karpiscak, 1980).

It might be argued that the situation in Arizona is more stable than other areas because a good portion of the water used comes from renewable surface supplies, and that soon Central Arizona Project water from the Colorado River will be delivered to the state. Thus, a figure of 20 percent idle cropland in the region (approximately 106,000 ha.) which is presumably available for production of new crops, may be conservative.

C. *Irrigated land (saline waters).* Lands that could be irrigated with saline waters to raise halophytic or salt-tolerant crops should be considered for new crop production. The environment that might be envisioned for production of these crops would be very similar to a conventional irrigated farm. However, the management of salt within the system would require somewhat different irrigation techniques.

Obvious candidate areas for saline irrigation would be existing agricultural lands, both active and retired, as discussed above. However, most halophytic crops are grown for forage and will be of lower value

## 14 • Natural Resources

than conventional crops. It is unlikely that halophytic crops will displace conventional ones if any fresh water is available. Thus, if this type of agriculture develops, the largest areas of change will be where salt has become a problem and in previously uncultivated areas.

Within the U.S. border region there are about 2 million ha. of land (or 8 percent total U.S. study area) that could be used for halophyte production. We believe that the amount of land in the Mexican border region suitable for halophyte production is probably comparable.

1. Slopes less than 10 percent;
2. Accessible saline water supply (greater than 3,000 ppm);
  - a) groundwater at less than 100 m.
  - b) seawater (sites within 15 m. of sea level); and
3. Outside of reserved areas (national parks, monuments, military facilities).

The distribution of these lands is shown in Figure 3.

D. *Marginal lands (dispersed perennial crop)*. Marginal lands are generally defined as lands on which some limiting factor prevents the establishment of conventional agriculture. The lands considered in this category are marginal in a conventional sense: they are suitable for cultivation if water is available. However, an unconventional use is proposed for them. Rather than establishing an intensive irrigated annual crop (such as cotton or wheat), it is proposed that these lands be used in a production system based on widely spaced perennial plants that would require only minimal supplemental irrigation during establishment. Additional watering could be supplied during poor rainfall years. The criteria for selecting these lands are:

1. Slope less than 10 percent;
2. Annual precipitation greater than 250 mm.; and
3. Outside of reserved areas.

The slope requirement is that of conventional limits on the operation of farm machinery. Although the use of general purpose machinery is unlikely, selection based on this slope criterion also would mitigate soil management problems.

The precipitation criterion, like others used in this exercise, is arbitrary. However, empirical work done at the University of Arizona using water-harvesting technology suggests that 250 mm. is a reasonable lower limit of annual precipitation to establish successful perennial crops. It is unlikely that any suggested perennial crop would do well on less precipitation without regular irrigation. The 250 mm. precipitation value is a minimum; the potential for crop success will increase with increases

CALIFORNIA

ARIZONA

San  
Diego  
Tijuana

Tucson

Nogales

Pacific  
Ocean

BAJA

CALIFORNIA

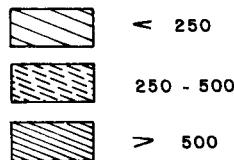
GULF OF CALIFORNIA

SONORA

## UNITED STATES-MEXICO BORDER AREA

Figure 1. Borderland Average  
Annual Rainfall

Precipitation (mm.)



Espenshade, E.B., Jr., and J.L. Morrison, eds. 1978. Environments. Pages 76-77 in Goode's World Atlas, fifteenth edition. Rand McNally & Company, Chicago. 372 p.

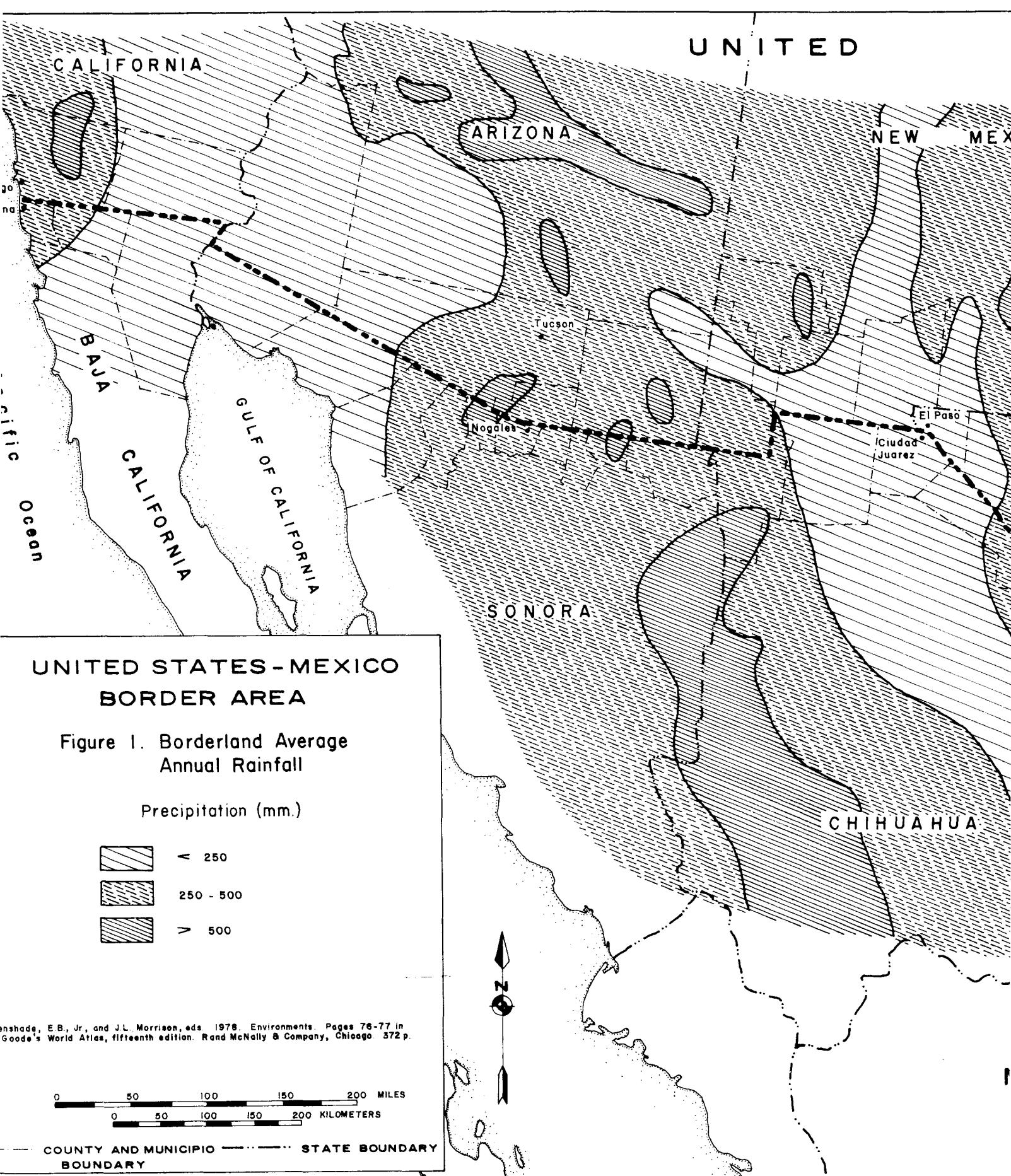
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— COUNTY AND MUNICIPIO — STATE BOUNDARY  
BOUNDARY



UNITED



## UNITED STATES-MEXICO BORDER AREA

Figure 1. Borderland Average Annual Rainfall

Precipitation (mm.)

- < 250
- 250 - 500
- > 500

Bonshade, E.B., Jr., and J.L. Morrison, eds. 1978. Environments. Pages 76-77 in Goode's World Atlas, fifteenth edition. Rand McNally & Company, Chicago. 372 p.

0 50 100 150 200 MILES  
0 50 100 150 200 KILOMETERS

COUNTY AND MUNICIPIO BOUNDARY ————— STATE BOUNDARY

# STATES

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UNITED STATES

Study  
Area

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TEXAS

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NUEVO

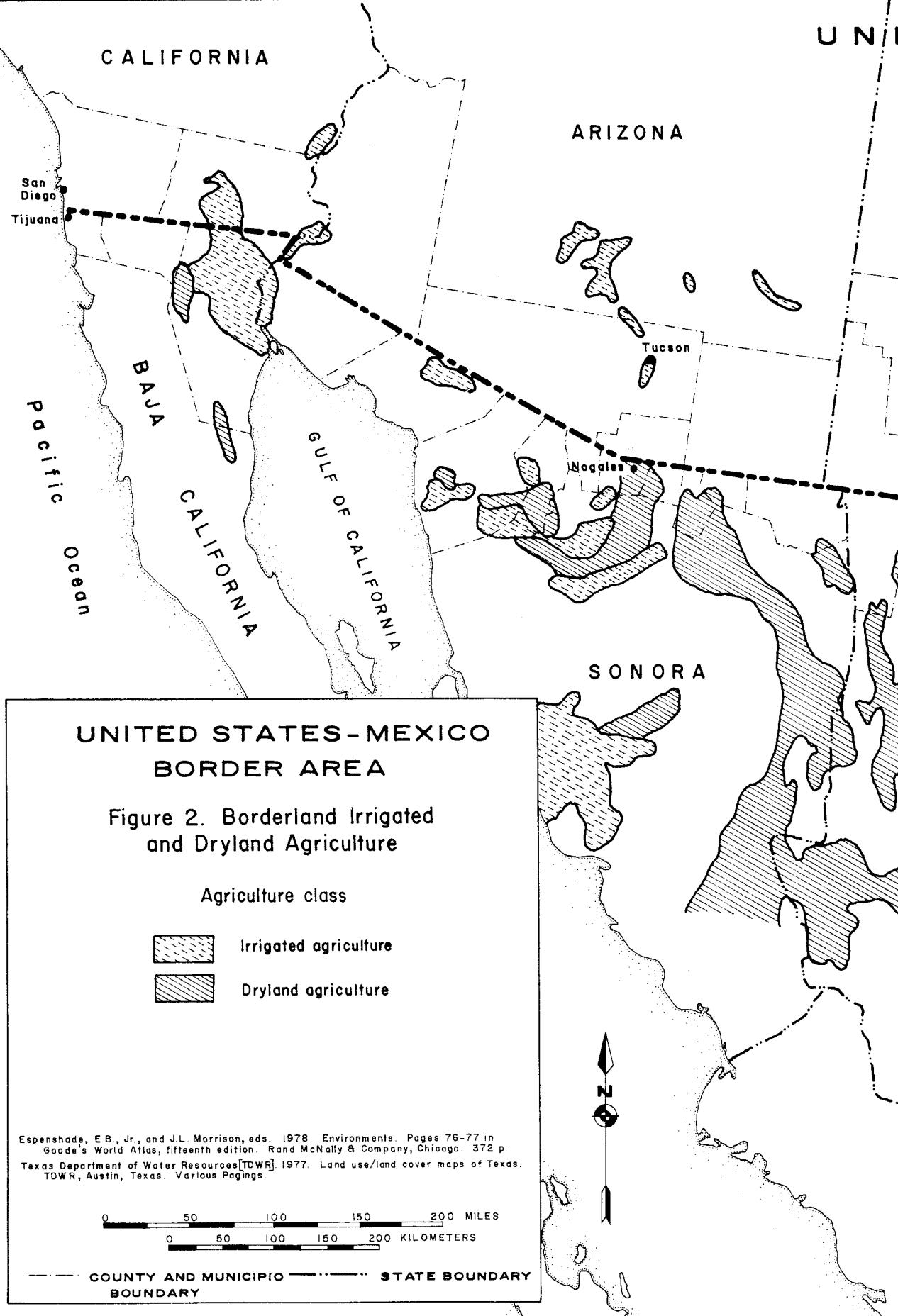
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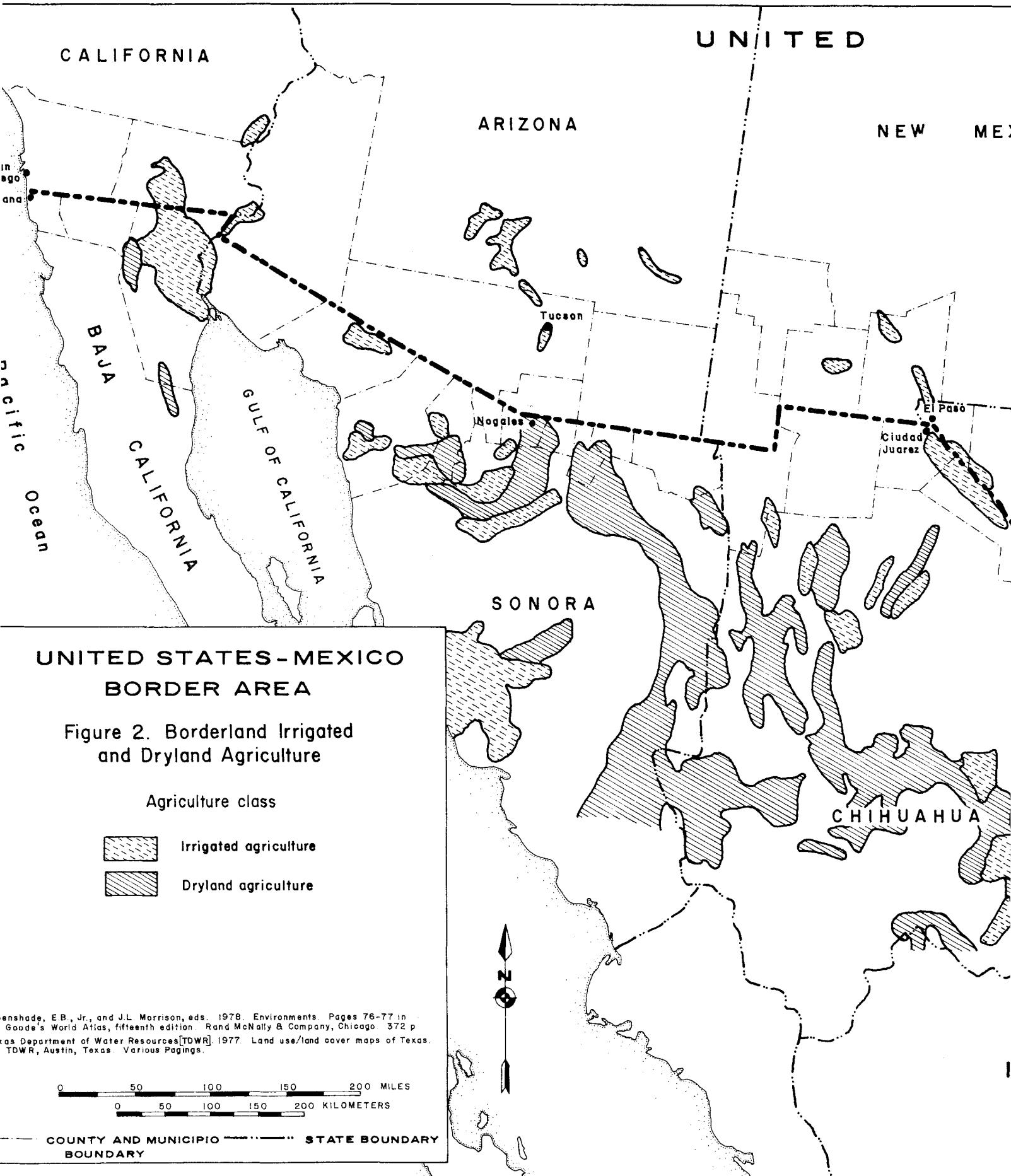
TAMAULIPAS

Gulf of Mexico

Brownsville

U N

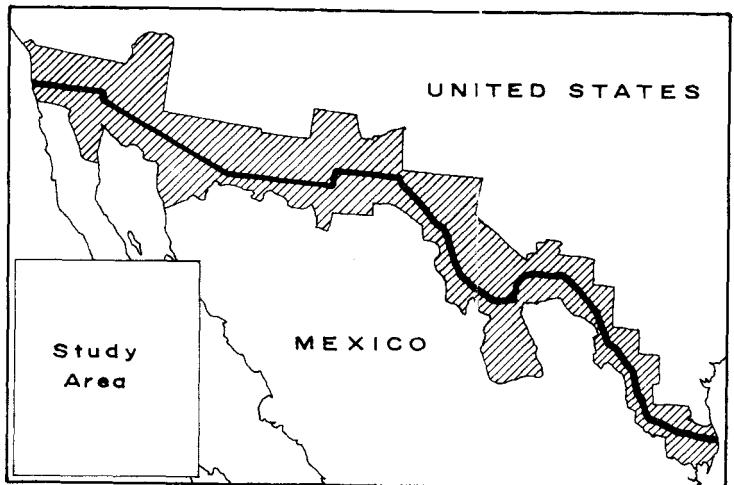




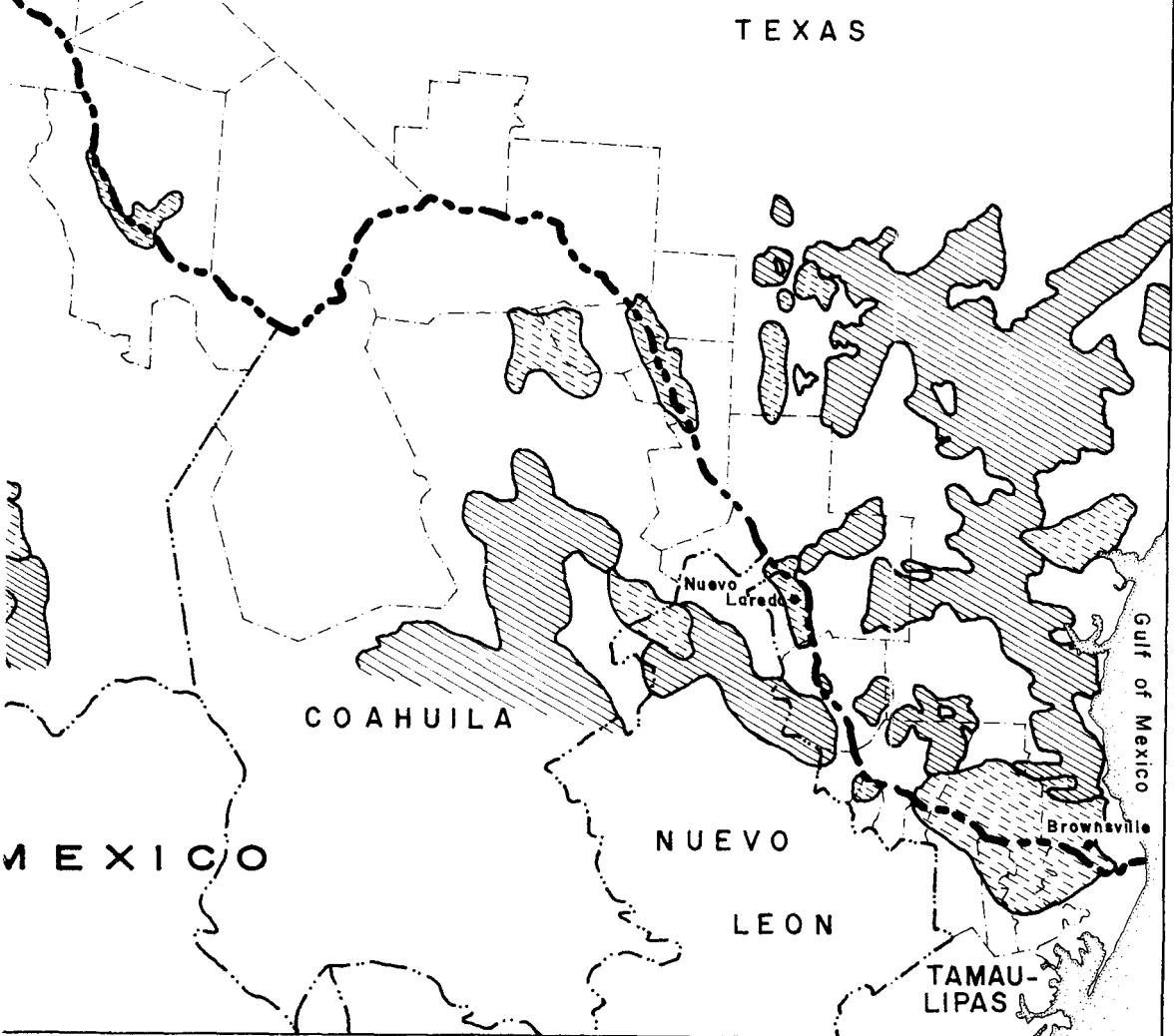
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Texas Department of Water Resources [TDWR]. 1977. Land use/land cover maps of Texas. TDWR, Austin, Texas. Various Pagings.

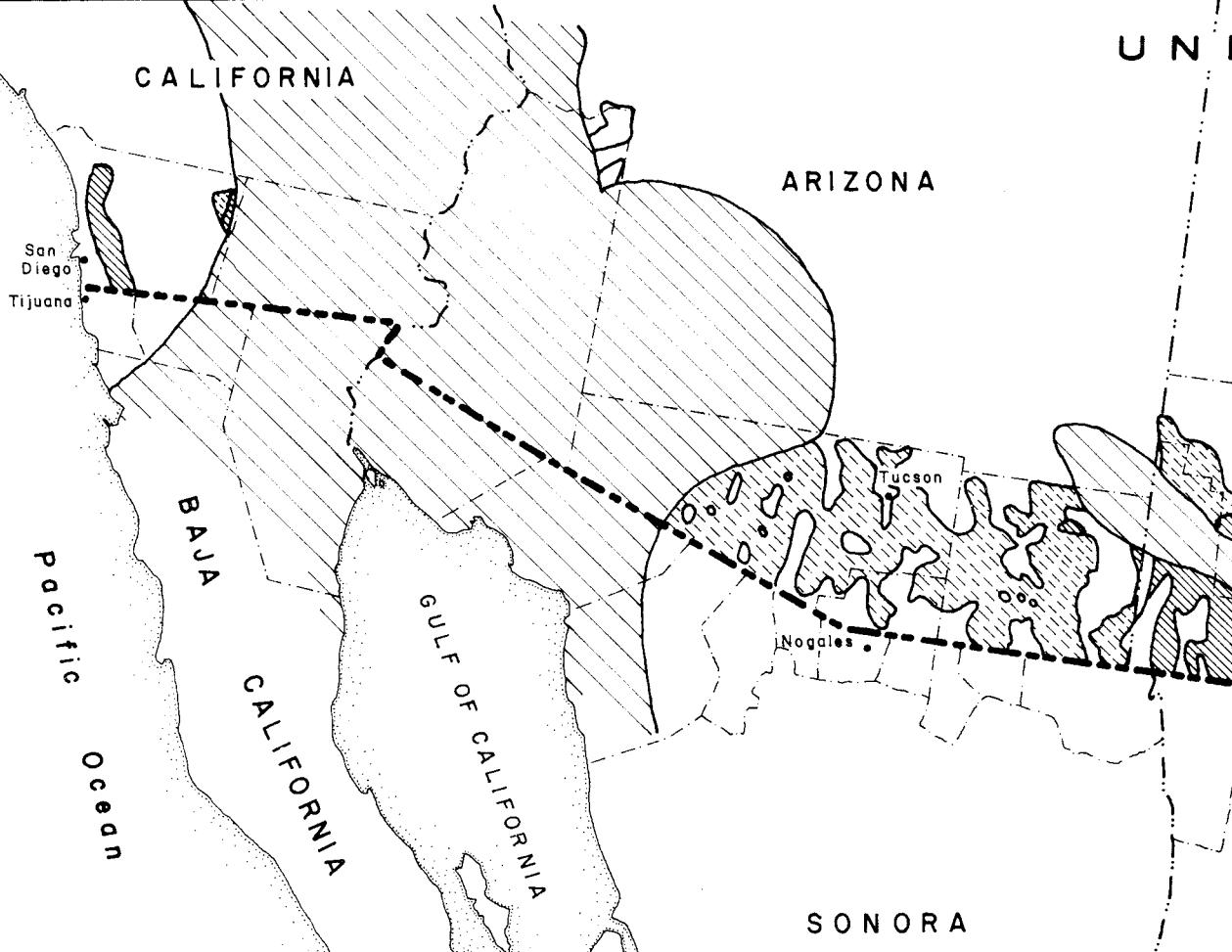
STATES

MEXICO



TEXAS





## UNITED STATES-MEXICO BORDER AREA

**Figure 3. Potential Saline-Irrigated and Marginal Dryland Agriculture**

### Potential agricultural Classes\*

\*Lands without rock/sand cover, outside of reserved areas, of less than 10 percent slope, and with annual rainfall equal to or exceeding 250 mm

- [Hatched Box] Saline-Irrigation potential
- [Hatched Box] Dryland potential
- [Hatched Box] Lands with <250 mm. annual rainfall

Espenshade, E.B., Jr., and J.L. Morrison, eds. 1978. Environments, Rainfall. Pages 76-77 and 74 in Goode's World Atlas, fifteenth edition. Rand McNally & Company, Chicago. 372 p.

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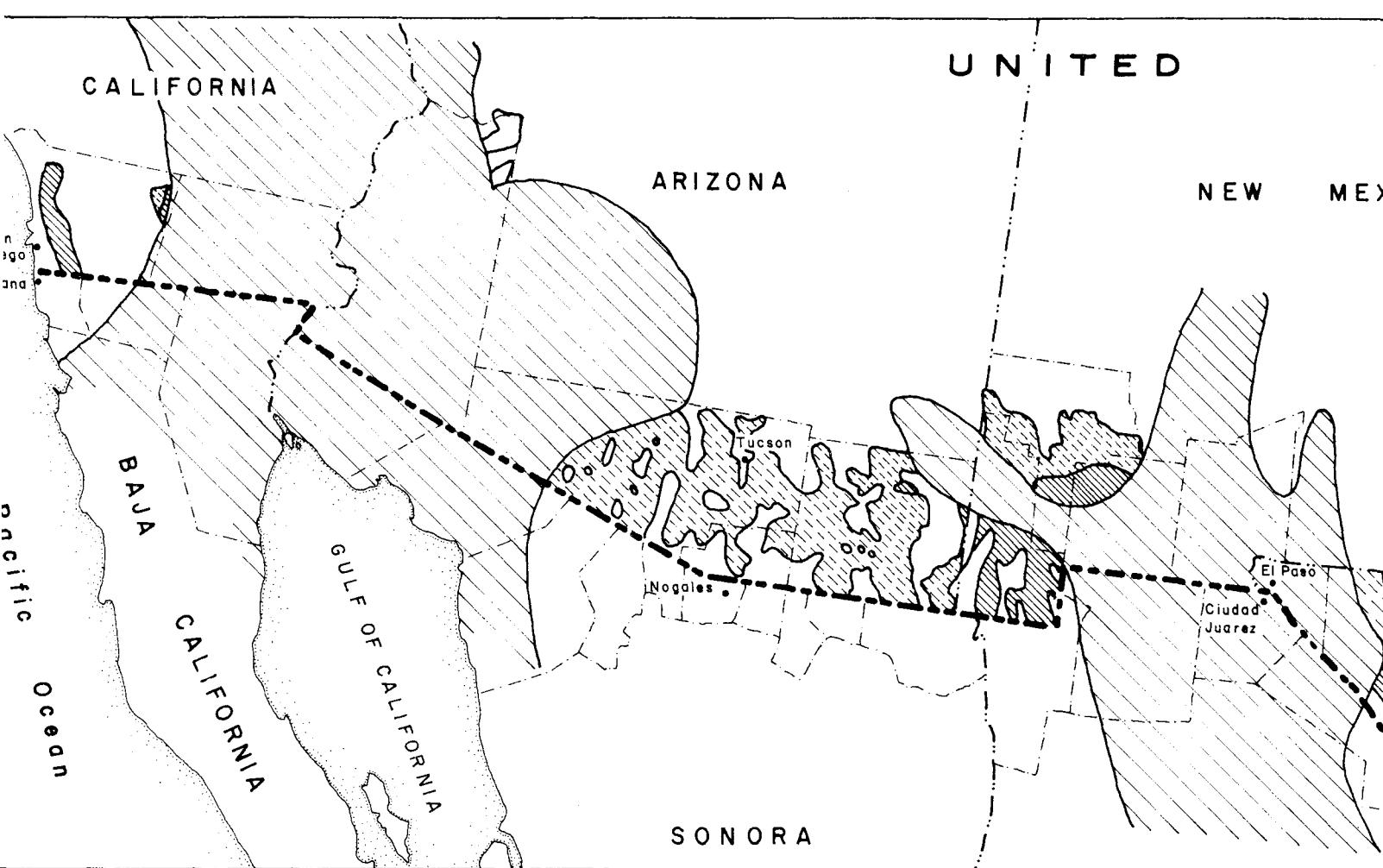
Fugro National Inc. No date. Topographic suitability, coarse screening, conterminous United States. U.S. Department of Defense, Department of the Air Force, SAMSO FN-TR-16. Various pagings.

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U.S. Department of the Interior, Geological Survey. 1968. Federal lands -- Principal lands administered or held in trust by federal agencies: January 1, 1968. Geological Survey, Sheet No. 272.

0 50 100 150 200 MILES  
0 50 100 150 200 KILOMETERS

— COUNTY AND MUNICIPAL BOUNDARY — STATE BOUNDARY



## UNITED STATES-MEXICO BORDER AREA

Figure 3. Potential Saline-Irrigated and Marginal Dryland Agriculture

### Potential agricultural Classes\*

\*Lands without rock/sand cover, outside of reserved areas, of less than 10 percent slope, and with annual rainfall equal to or exceeding 250 mm

- Saline - Irrigation potential
- Dryland potential
- Lands with <250 mm. annual rainfall

Enshad, E.B., Jr., and J.L. Morrison, eds. 1978. Environments, Rainfall. Pages 76-77 and 74 in Goode's World Atlas, fifteenth edition. Rand McNally & Company, Chicago. 372 p.

J.H. et al. 1965. Preliminary map of the conterminous United States showing depth to and quality of shallowest ground water containing more than 1,000 ppm dissolved solids. U.S. Department of the Interior, Geological Survey Report HA-199. 31 p.

Geo National Inc. No date. Topographic suitability, coarse screening, conterminous United States. U.S. Department of Defense, Department of the Air Force, SAMSO FN-TR-16. Various pagings.

U.S. Department of Water Resources [TDWR]. 1977. Land use/land cover maps of Texas. TDWR, Austin, Texas. Various pagings.

Department of the Interior, Geological Survey. 1968. Federal lands -- Principal lands administered or held in trust by federal agencies: January 1, 1968. Geological Survey, Sheet No 272.

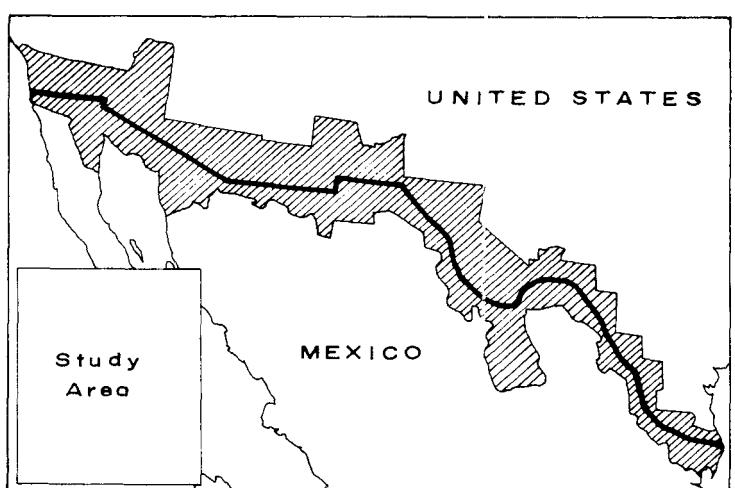
0 50 100 150 200 MILES  
0 50 100 150 200 KILOMETERS

— COUNTY AND MUNICIPIO BOUNDARY — STATE BOUNDARY



STATES

MEXICO



in precipitation and the proportional increase of precipitation concentration in the summer growing season. Thus, it is likely that the potential for success would increase: 1) with elevation; and 2) to the east of the region.

Given these criteria, we find that there are about 7.5 million ha. of land suitable for the production of dispersed perennial crops within the region. This includes the .4 million ha. of land in Texas that is currently dry-farmed. The distribution is shown in Figure 3.

E. *Wild harvest.* The development of wild harvests as an agricultural proposal is difficult to address. While this activity has been conducted since man arrived on the continent, it has only existed as a viable economic activity in Mexico. Essentially all the guayule and candelilla that is produced in Mexico comes from wild harvest. In recent years, wild harvest has been proposed in the United States with the increase in demand for jojoba products; however, outside of frequent discussion there have been no attempts to manage these resources. Given the direct role of the marketplace in driving wild harvests, it is unlikely that much can be done to develop it. If the market for any crop improves to the point where there is sustained demand at a relatively high price, the crop will eventually become established as a field or plantation crop. Because of these problems, and the unique distribution of most plants with crop potential, no estimates of production area are presented.

#### POTENTIAL NATURAL RESOURCES

The natural resources of the border region include recreation, grazing, wildlife, oil and minerals, and land and water used for agricultural production of both traditional and new crops.

While our assignment was to discuss the natural resources of the region and the potential for development, we have concentrated our efforts on the use of wild plants for new arid lands crops. We feel that the economic potential for agricultural production of new crops throughout the border region is economically greater than any of the other natural resource development options, with the possible exceptions of oil and other minerals. The possibility of converting some of the under-utilized arid lands of the border region for production of food/feed, fiber, industrially important chemicals or energy is our general thesis. In Table 1, we have indicated potential uses of plants including food/feed, fiber, medicine, chemicals and energy.

The use of arid lands plants for food, fiber and medicine is described by Felger (1979) in the American Association for the Advancement of Science publication *New Agricultural Crops*. Although the potential for

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using some of the arid lands plants for food is established in the ethnobotanical literature, the acceptance of many of these arid lands plants is slow and often controversial. Possibly the most controversial of all is mesquite.

An excellent review of mesquite and its potential is presented by Felker (1979). The plant is leguminous. It produces pods containing approximately 13 percent protein and 30 percent sucrose. The wood is widely used as a fuel in the United States and Mexico. Mesquite often is considered a pest because of its high water use and its invasion into grazing lands. Other potential food crops include buffalo gourd, teparies, amaranth and other arid lands plants.

In the last decade some exciting research has been conducted throughout the border region, in both Mexico and the United States, regarding the production of chemicals from arid lands plants. Two plants receiving the most attention are guayule and the jojoba. Guayule appears to be an excellent source of rubber as outlined by Vietmeyer (1979) and Foster, et al. (1979). Jojoba has been well publicized in the print and electronic media. Its development has taken on an almost circus atmosphere with claims being made about the virtues of jojoba oil that are not fully supported by scientific documentation. An excellent review of jojoba has been presented by Hogan (1979).

Since 1978, the University of Arizona, with support by the Diamond Shamrock Corporation, has concentrated a research effort in the area of energy and chemical production from plants. This research has resulted in the collection and analysis of more than 400 plants from the border region. All of the plants collected were subjected to extraction with cyclohexane followed by ethanol. A voucher specimen of each plant was deposited in the University of Arizona herbarium. Associated with these specimens are field notes, which include habitat, height and pertinent environmental and phenological data.

One of the major contributions of this research was a set of selection criteria developed by McLaughlin and Hoffmann (1982) which utilizes an estimate of biomass yield combined with the chemical analysis and an estimate of growing costs. This permits a direct comparison between plants in terms of their predicted yields and cost to produce per unit of energy. This criterion was used to reduce the large number of plants collected to a manageable number. We are now conducting secondary level evaluation studies on a few candidate species.

The secondary level evaluation includes further chemical analysis and characterization of the extract as well as agronomic and economic evaluations based upon greenhouse and field studies. The purpose for the second level evaluation is to determine which of these candidate plants should then be taken through the very expensive steps of plant domestication.

TABLE 1  
Potential Nonconventional Crops for the Border Region:  
Products and Cultivation Schemes

PLANT	PRODUCTS					CULTIVATION SCHEMES				
	Food/Feed	Fiber	Medicine	Chemicals	Energy	Irrigated (active)	Irrigated (retired)	Irrigated (saline waters)	Marginal	Wild Harvest
<i>Acacia</i> spp.				X	X	X			X	X
<i>Agave</i> spp.	X	X	X	X		X	X		X	
<i>Amaranthus</i> spp.	X					X	X			
<i>Amorphophallus canescens</i>					X					
<i>Amsonia</i> spp.					X	X				
<i>Artemesia tridentata</i>						X			X	
<i>Asclepias</i> spp.			X		X	X				
<i>Atriplex</i> spp.	X					X	X	X		
<i>Baccharis</i> havardii					X		X			
<i>Bothriochloa</i> turbinoides					X		X			
<i>Cactus</i> family	X	X	X	X					X	X
<i>Cenchrus ciliaris</i>					X		X			
<i>Ceratonia</i> spp.	X			X	X		X			
<i>Chrysanthemum coronarium</i>				X	X		X			X
<i>Chrysanthemum paniculatus</i>				X	X		X			
<i>Cucurbita foetidissima</i>	X						X			
<i>Dundelia</i> spp.	X			X	X				X	
<i>Ephedra</i> spp.			X				X		X	
<i>Euphorbia antisyphilitica</i>				X	X		X			
<i>Euphorbia hirta</i>			X				X			
<i>Euphorbia lathyris</i>					X		X	X		
<i>Grindelia camporum</i>				X	X					
<i>Hellianthus annus</i>					X		X			
<i>Kochia scoparia</i>					X					
<i>Lorrea tridentata</i>				X	X		X		X	X
<i>Leucadenon retusa</i>					X			X		
<i>Panthenium argenteum</i>				X	X		X	X		X
<i>Pedilanthus macrocarpus</i>				X	X		X			
<i>Phaseolus acutifolius</i>	X						X	X		X
<i>Pinus eldarica</i>					X		X			
<i>Prosopis</i> spp.	X			X			X		X	X
<i>Rumex hymenosepalus</i>				X			X			
<i>Salsola kali</i>					X		X		X	X
<i>Simmondsia chinensis</i>			X	X	X		X	X		X
<i>Sorghum</i> spp.	X				X		X	X		
<i>Sporobolus airoides</i>					X			X	X	
<i>Xanthocephalum gymnospermoides</i>					X	X				
<i>Yucca</i> spp.	X		X	X	X		X	X	X	X
<i>Zosterophyllum</i>	X							X		

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The only plant in this research effort that has been subjected to the extensive research leading toward plant domestication is *Euphorbia lathyris*. *E. lathyris* seeds were collected or purchased from around the world. Several acres of *E. lathyris* have been planted in Arizona, California, Nevada, New Mexico, Colorado, Utah and Texas. The principal difficulty with *E. lathyris* is its susceptibility to heat stress and root pathogens (Young and Alcorn, 1981). As a result of the pathogenicity and heat stress problem, it was decided that *E. lathyris* must be grown as a winter crop to avoid high summer temperatures. The first 1-acre plot, planted in 1978, succumbed to pathogens and heat; hence, no biomass yield. By 1981, however, we were able to obtain a biomass yield of approximately 14 tons per hectare (McLaughlin, et al. 1982).

The analyses conducted at the University of Arizona have indicated a rather questionable future for *E. lathyris* in the border region. We feel we have proven that a valuable "biocrude" can be produced by *E. lathyris*; however, we feel that it is not feasible to consider *E. lathyris* for commercialization in the United States-Mexico border region. (Biocrude is a term coined to indicate the hydrocarbon and hydrocarbon-like material produced by and chemically extracted from a plant. Biocrude may be "cracked" into gasoline or refined into valuable petrochemical feedstocks. The *E. lathyris* biocrude was submitted for catalytic cracking and was found to have a value comparable or exceeding that of crude oil pumped from the ground and delivered to Diamond Shamrock's refinery in Texas.)

Our research with new candidate species, particularly *Asclepias* spp., *Amsonia* spp., *Chrysanthemum* spp., *Xanthocephalum gymnospermoides* and *Grindelia camporum*, appear particularly promising because they are indigenous to arid lands and they are less susceptible to the problems associated with heat stress and soil fungi. They also appear to have extractable chemicals that may produce a biocrude with considerably higher value than *Euphorbia lathyris*.

### RESEARCH NEEDS

We recognize that each class of crops we have discussed will have a unique set of associated problems that first must be overcome before the crops will be adopted by farmers. For example, halophytic agriculture will require the development of new irrigation techniques before it can become viable. Similarly, the development of an agriculture based on widely spaced perennial plants will be based on the development of new plant and land management techniques. However, assuming that these unique obstacles are overcome, there still is a wide array of more familiar problems that must be solved before crops can be introduced

into conventional settings. Thus, in attempting to define research problems that would be encountered by "domesticating" any new crop, the channels of research that have been pursued in recent attempts to develop a new crop should be considered.

At present, considerable attention is being given to jojoba, because of popular interest in the plant and the consequent variety of investment "opportunities" that are being promoted. This interest is reflected in a broad array of research that has been done recently. The problems that have arisen in bringing this plant into profitable commercial production, and the types of research that have been conducted to address these problems are summarized below.

*Culture and reproduction.* Commercially desirable characteristics of the jojoba plant have not been established. Some considerations include drought and salt tolerance, tolerance of temperature extremes, flowering and fruiting ability, disease resistance, predictable oil content of seeds, and seed size (Gentry, 1958). While work proceeds on defining desirable traits, other research must be directed toward collecting and describing wild populations of jojoba from which genetic material must be drawn.

Research is in progress on developing reproduction techniques through tissue culture and cuttings, but no strains have been marketed. Seed is available, but the characteristics of the plant are not adequately known. Thus, all research on reproduction depends on establishing desirable traits for plantation agriculture, and gathering genetic materials to develop those traits.

*Cultivation and management.* Questions regarding the establishment and maintenance of jojoba plants in conventional agricultural settings have not yet been answered. Problems include time of planting, temperature requirements, plant spacing and irrigation requirements.

The amount and quality of water required to maintain jojoba needs additional study, as does the suitability of various irrigation techniques and regimes. Soil requirements, necessary amendments, and pesticides are all unknown. However, a number of experimental jojoba plantations have been established already. The experience gathered from these plantations will supplement formal research and will contribute to the development of a body of techniques for managing jojoba on a large scale.

*Harvesting techniques.* At present, all jojoba is hand harvested. Research is underway to develop new machinery or to modify existing nut and berry harvesting equipment. Other research is being conducted on pruning or training shrubs to accommodate harvesting equipment (Yer-  
manos, 1976).

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*Processing.* Preprocessing and mechanical extraction have been adapted from standard techniques used with other seed crops. Solvent extraction techniques have been used, but the technique is not fully developed. The production of other valuable by-products through hydrogenation and sulfurization has been examined in the past but requires further research.

*Economic feasibility.* The costs of establishing a plantation are known in general; however, because no plantation has produced a crop, production and harvest costs are unknown. In addition, the market is highly uncertain: prices have been relatively high, for the most part, because of low and uncertain supply. When plantations do come into production, the market response is likely to be unfavorable without new product development (Ragless, 1979; Wright, 1980).

Moreover, successful competition with other better known and more easily acquired oils and waxes may prove difficult. It has been suggested that to be successful, jojoba must enter the market at less than \$ 1 per pound. Yet, in 1981, wholesale prices ranged between \$ 14 and \$ 28 per pound (Rawles, 1982).

*Product development.* Essentially all jojoba is now used in specialty products such as cosmetics, personal care products, lubricant additive, and raw oil (for the health food market). The full range of potential uses of the oil and other byproducts has not yet been explored.

*Wild harvest.* All jojoba produced now comes from wild harvest and will continue even when plantations come into production. Thus, even though we have dismissed wild harvest as a major development alternative, it must be addressed as an issue in jojoba development.

There are many difficulties associated with wild harvests. First, the supply is unpredictable with wide variations in yield from year to year. Second, the harvest is labor intensive: stands are scattered, access is difficult, yields are often low, and the work force also may be unreliable.

Environmental impacts of wild harvest are unknown. The natural replacement pattern of the plant is altered by removing large amounts of seed. Natural contours may be altered to ensure the delivery of water to individual jojoba plants in manipulated stands using water-harvesting techniques. Roads and trails may be cut to provide more convenient access to isolated stands. The consequences of these disturbances are unknown (Foster, et al., 1980).

Finally, the impact on local fauna is unknown. Jojoba plants provide forage for deer and other game. The more specific symbiotic relationships between jojoba and other animals, such as Bailey's pocket mouse, are

not fully understood. Thus, wild harvest of an apparently "free" resource may not be so benign as originally assumed.

*Land evaluation.* Aside from the specific problems associated with developing a new crop, there is a need to identify those areas in which the plant might be grown. An underlying theme of most research done on arid lands plants, is that because of their adaptation to harsh conditions, we may be able to use them on lands that were not previously productive. As indicated above, there is increasing pressure on these marginal lands especially in Mexico; thus, it is highly desirable to find ways in which to profitably exploit them. Even though these plants are in some ways hardy and capable of surviving rather extreme climates, many are still best adapted to a relatively narrow range of environmental conditions. For example, a plant such as jojoba may be adapted to relatively low rainfall, periodic drought, and steep rocky terrain, but it is highly susceptible to frost. At first glance, much of the border region would be considered suitable for jojoba production; but in fact, large areas must be eliminated because of frost hazard.

Historically, the lands of this region have not been highly regarded for agricultural development because of the difficulty in supporting conventional agriculture. As a result, there have been no sustained efforts to characterize the climatic and soil resources of the region. When confronted with the problem of selecting areas that are best suited for production of a new crop, having specific climatic and soil requirements, there is very little in the way of resource information on which to draw.

Moreover, those resources that have been judged of little or no value in the past, such as saline waters, correspondingly are little known. Although their occurrence is known or can be predicted with some confidence, the amount and the precise quality is not known.

The difficulties in estimating the amount of land within the region potentially available for agriculture are attested to in the maps that we have presented. A good part of our estimates are based on incomplete data and guesswork: it is impossible, at this time, to simply compile maps of any feature of the border region based on published maps. A considerable amount of work remains to be done in characterizing the basic resources of the region on both sides of the border.

#### SUMMARY AND CONCLUSIONS

The picture we have presented, in terms of land availability and potential agricultural productivity, is bright and promising in spite of several obstacles. There are large areas of retired agricultural land that could be brought back into production, and there are areas of under-

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utilized lands that could be made productive. There are a number of plants and production schemes that may be viable alternatives to conventional agriculture on many of these lands.

We have presented some of the agricultural development opportunities that have technical and economic promise, and we have outlined some of the research needs that must be met before these opportunities can be realized. However, the more complex and telling considerations of markets, finance, land tenure, social acceptability, technological adaptability, and the willingness to adopt new and significantly different systems of agriculture and products ultimately will determine the future of agriculture in the region. The physical situation that faces each country is similar. The common constraints are lack of precipitation or suitable water supplies, accumulated salts in irrigated areas and erosion. The social, economic and technological factors that intensify or ameliorate impacts are substantially different for each country; the technical solutions to these problems may be identical, but the ways in which they are achieved are likely to be quite different.

Based on the history of the region, regardless of what we as scientists or managers decide as reasonable or desirable, increasing population and decreasing water supply will intensify the pressure on these lands. Regional and local economies, prior investment, demography, individual incentive, and perhaps common sense, will argue that agricultural production in the region should be sustained. However, the agriculture of the future in this region is likely to be substantially different from what it is today.

If agriculture is to continue as an economically viable industry in the region then, short of interbasin water transfers of previously unimagined scales, the sociology and technology of agriculture must undergo significant change. We think the long-range future of agriculture in the region will be determined by new low-water (or poor-water-quality) use crops and that these crops may be of substantially lower biomass yields than currently realized on irrigated lands. Possibly some of the crops we have mentioned will fill the niche, possibly some current crops will be adapted; or, even more likely, some of the plants that will be researched during the next few years will provide the new and vigorous agricultural base for the region. Finally, because of the diversity of problems that must be solved we feel that it is imperative to increase joint research activities between United States and Mexican scientists.

## *APPENDIX A*

### UNITED STATES-MEXICO BORDER REGION GOVERNMENT AGENCIES, RESEARCH INSTITUTIONS AND COMMISSIONS

The following is a selected list of government agencies, research institutions and commissions in Mexico and the United States that initiate and coordinate natural resource development programs in the border region. We have emphasized those organizations directly involved in the research and development of new crops for arid lands.

The list is organized into three categories: government agencies, research institutions, and commissions. Each entry includes: the name and location of the organization, date the information was obtained, director, research activities, and publications.

Information was obtained from a variety of sources including telephone conversations, written correspondence, and from publications and brochures. The following works and their authors contributed the detailed information on which this list is based.

JAMAIL, M. H. 1980. *The United States-Mexico border: A guide to institutions, organizations and scholars*. University of Arizona, Tucson, Latin American Area Center.

PAYLORE, P. 1977. *Arid lands research institutions. A world directory*. Tucson, University of Arizona Press, Tucson.

Both the United States and Mexico are interested in developing the arid zone they share. The number of organizations involved in this effort is considerable. This list should encourage contacts and information exchanges among these groups and individuals. Ultimately, the sharing of experience gained on both sides of the border will speed the development of the arid zone and will enhance the future of both countries.

**MEXICAN GOVERNMENT AGENCIES**

**Centro de Ecodesarrollo**

1981

Altadena N° 8, Col. Nápoles  
México, D. F.

*Director:* Iván Restrepo

The Centro de Ecodesarrollo is concerned with rural development and has been involved in guayule research, alternative development strategies for arid lands, social impacting contamination on the U. S.-Mexican border and socioeconomic studies of squatter settlements in border communities.

**Comisión Coordinadora del Programa de Desarrollo de las Franjas  
Fronterizas y Zonas Libres (CODEF)**

1980

SECRETARÍA DE PROGRAMACIÓN Y PRESUPUESTO  
Fray Servando Teresa de Mier  
Nº 77-11º piso  
México, D. F.

*General Coordinator:* Edmundo Victoria Mascorro

CODEF was established in 1977 to monitor the actions of federal agencies dealing with the social and economic development of the border regions and free zones. Members of the commission are from various federal secretaries including the Secretaría de Agricultura y Recursos Hídricos (SARH). CODEF established close ties with the Southwest Border Regional Commission to work on common border problems with the United States. It is not clear who will become CODEF's United States contact now that the Southwest Border Regional Commission has been dismantled.

**Comisión Nacional de las Zonas Áridas (CONAZA)**

1980

Tonalá N° 30, PB  
México 7, D. F.

*Director:* Francisco Güel Jiménez

CONAZA provides funding for research on jojoba and encourages farmers to grow it. Additionally, CONAZA performs field studies relating to distribution and potential values of arid lands plants.

**Consejo Nacional de Ciencia y Tecnología (CONACYT)**

1981

Centro Cultural Universitario  
México 20, D. F.

*Director:* Edmundo Flores

CONACYT is the Mexican equivalent of the United States National Science Foundation. Accordingly, its principal goals are to promote research and to act as a consultant for the government in solving problems implicit in the advancement of science and technology. CONACYT funds research program and other research organizations ,administers scientific agreements with other countries and is the lead agency for the United States- Mexico Mixed Commission Working Group on Research Development. CONACYT is particularly interested in new crops for arid lands, and in increasing agricultural productivity.

**Coordinación General del Plan Nacional de Zonas Deprimidas  
y Grupos Marginados (COPLAMAR)**

1981

*Director:* Ignacio Ovalle Fernández

COPLAMAR is an umbrella organization, responsible directly to the President, that channels money into specific projects concerning marginal lands. It is particularly interested in services for rural areas and is likely to be involved in the development of guayule and jojoba as new crops.

**Secretaría de Agricultura y Recursos Hídricos (SARH)**

1979

Insurgentes Sur 476  
México 7, D. F.

*Director:* Francisco Merino Rábago

SARH is a Mexican cabinet-level department. It oversees such institutes as the Instituto Nacional de Investigaciones Agrícolas and the Instituto Nacional de Investigaciones Forestales. SARH was named as one of the responsible institutions to expand research collaboration between Mexico and the United States particularly in the areas of desertification, forestry research and crop and livestock production.

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**Secretaría de Agricultura y Recursos Hidráulicos,  
Comisión Nacional de Fruticultura (CONAFRUT)**

1979

Km. 14.5 Carretera México-Toluca  
México 18, D. F.

*Contact:* Mohanlal Morzaria B.

CONAFRUT was one of the institutions cited by the United States-Mexico Mixed Commission on Scientific and Technical Cooperation to work on developing candelilla commercially as a source of natural wax.

**Secretaría de Agricultura y Recursos Hidráulicos,  
Instituto Nacional de Investigaciones Agrícolas (INIA)**

1981

Chapingo

*Director General:* Jesús Moncada

INIA is funded by the federal government of Mexico. INIA controls five research stations throughout the arid and semiarid zones of Mexico including CIANO. Studies include plant breeding investigations on various dryland crops, plant pathology, weed control, entomology and soil fertility and management. INIA specializes in developing new crops and has done extensive research in jojoba plantations.

*Publications:* *Novedades Hortícolas* and *Agricultura Técnica en México*

**Secretaría de Agricultura y Recursos Hidráulicos,  
Instituto Nacional de Investigaciones Forestales (INIF)**

1978

Avenida Progreso N° 5  
México 21, D. F.

*Director General:* Avelino B. Villa Sales

INIF research interests include photogrammetry, silviculture, national forestry conservations and wildlife management. Its affiliate, Instituto Nacional de Investigaciones Forestales del Noroeste, has been involved in jojoba research

*Publications:* *Information and technical bulletins*

**Secretaría de Agricultura y Recursos Hidráulicos,  
Instituto Nacional de Investigaciones Agrícolas,  
Centro de Investigaciones Agrícolas del Noroeste (CIANO)**

1979

Apartado Postal N° 515  
Ciudad Obregón, Sonora

*Director:* Ernesto Samayou Armienta

CIANO is the northwestern agricultural research center located near Hermosillo, Sonora. CIANO conducts research on jojoba and other arid-land crops.

#### MEXICAN RESEARCH INSTITUTIONS

**Centro de Investigaciones Biológicas de Baja California (CIB)**

1980

Melchor Ocampo N° 312  
La Paz, Baja California Sur

*Director:* Félix Córdoba

CIB conducts studies on jojoba and other arid lands plants.

**Centro de Investigaciones Científicas y Tecnológicas  
de la Universidad de Sonora (CICTUS)**

1981

Hermosillo, Sonora

*Director:* Xicoténcatl Murietta

CICTUS is the technological research center at the University of Sonora. CICTUS studies jojoba, halophytic cultivation with seawater, canaigre, shrimp and natural resources development.

Publications: *Miscellaneous papers*

**Centro de Investigación en Química Aplicada (CIQA)**

1981

Saltillo, Coahuila

*General Director:* Enrique Campos López

CIQA is involved in arid lands development. Researchers at CIQA have worked on the development of jojoba, candelilla, guayule, and other natural

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resources of the Chihuahuan Desert. CIQA is particularly interested in developing new crops for marginal lands.

Publications: *Desierto y Ciencia*

### **Instituto de Investigación de las Zonas Desérticas**

1977

Plaza de Fundadores  
San Luis Potosí, San Luis Potosí

*Director:* Fernando Medellín-Leal

The Instituto de Investigación de las Zonas Desérticas is affiliated with the Universidad Autónoma de San Luis Potosí. The institute's main interest is renewable natural resources in the arid zones of Mexico. Studies have included the flora, geohydrology and fauna of the arid zone of San Luis Potosí.

### **Universidad Autónoma Agraria Antonio Narro (UAAAAN)**

1979

Saltillo, Coahuila

*Research Director:* Aristeo Acosta Carreón

UAAAAN was named by the United States-Mexico Mixed Commission on Scientific and Technical Cooperation as one of the responsible institutions for developing guayule, jojoba and candelilla as commercially viable new crops.

### **Universidad Autónoma Chapingo**

1978

Domicilio Conocido,  
Chapingo

*Rector:* Rogelio Posadas del R.

Research interests of the Universidad Autónoma Chapingo include agricultural economics agricultural industries, irrigation, rural sociology and soil science.

Publications: *Agrociencia*

**Escuela Superior de Agricultura Hermanos Escobar**

1981

Carretera Panamericana Km. 12 1/2  
Ciudad Juárez, Chihuahua

*Director:* Fernando Rincón Valdez

The Escuela Superior de Agricultura is working on a study of the ecology of the arid and semiarid zone of the state of Chihuahua. The University of Texas, El Paso, also is involved in this work.

**Instituto de Ecología, A. C.**

1978

Apartado 18-845  
México 18, D. F.

*Director:* Gonzalo Haffter

Instituto de Ecología researches biotic resources conservation, the dynamics of ecosystems, animal ecology and biogeography.

**Instituto de Investigaciones de Estudios Superiores Noroeste (IIESNO)**

1981

Hermosillo, Sonora

*Director:* Carlos E. Peña

IIESNO was established in 1978 to perform social science research. Areas of concern include nutrition and food science with future plans for work in integrated regional development. A name change to Centro de Investigaciones de Agricultura y Desarrollo Económico (CIADE) is planned.

**UNITED STATES GOVERNMENT AGENCIES**

**National Science Foundation (NSF)**

1981

1800 G. Street N. W.  
Washington, D. C. 20550

*Director:* John B. Slaughter

NSF promotes international cooperation through science. Activities include cooperative scientific research activities, and the execution of jointly designed research projects.

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**United States Department of Agriculture (USDA)**

1981

Washington, D. C. 20250

*Secretary of Agriculture:* John R. Block

The USDA was named by the United States-Mexico Mixed Commission on Scientific and Technical Cooperation as the United States lead agency in developing new crops for marginal lands. Particular emphasis was placed on the crops guayule, jojoba and candelilla. The USDA also is involved in monitoring desertification.

**United States Department of Agriculture, Office of International Cooperation and Development (OCID)**

1981

United States Department of Agriculture  
Washington, D. C. 20250

*Director:* Quentin M. West

OCID directs USDA efforts in international development, technical cooperation, and food and agriculture research. OCID also provides scientific and institutional resources from United States agriculture to United States and international organizations that carry out development assistance programs.

**United States Department of Agriculture, United States Salinity Laboratory**

1981

P.O. Box 672  
4500 Glenwood Dr.  
Riverside, California 92501

*Director:* Jan van Schelfgaarde

Current research programs of the United States Salinity Laboratory include breeding crops for enhanced tolerance and using saline waste water for irrigation and salinity monitoring. Field projects are located in the Imperial and San Joaquin valleys.

**United States Department of Agriculture, Science  
and Education Administration (SEA)**

1981

United States Department of Agriculture  
Washington, D. C. 20250

*Associate Director:* Clare I. Harris

SEA participated in the United States-Mexico Mixed Commission Preparatory Meeting Working Group on Research Development of New Crops, Arid Lands, and Agricultural Productivity. SEA was designated as one of the institutions to be involved in the research and development of new crops such as guayule, jojoba and candelilla. SEA has four regional offices for agricultural research in the United States. The regional offices cooperatively manage research activities in field locations with state agricultural experiment stations.

**United States Department of Agriculture, Water Conservation Laboratory,  
Agricultural Research Service (ARS)**

1981

4331 E. Broadway  
Phoenix, Arizona 85040

*Director:* H. Bouwer

The United States Water Conservation Laboratory is primarily involved in research on the development and efficient use of water supplies for agriculture in arid regions.

**United States Department of Energy (DOE)**

1980

Forrestal Building  
Room 7F089  
Washington, D. C.

*Contact:* Kay McKouoh or Bill Carter

The DOE has a bilateral agreement with Mexico for exchanging information on solar and geothermal energy. The DOE has been particularly interested in developing alternate energy sources, emphasizing solar energy in the United States Southwest.

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### **United States Department of the Interior, Bureau of Reclamation, Engineering and Research Center**

1980

P. O. Box 25007  
Denver Federal Center  
Denver, Colorado 80225

The Bureau of Reclamation, Engineering and Research Center assists state and local governments and other federal agencies in protecting the environment and quality of life through the development of water resource projects in the 17 western states and Hawaii.

*Publications: Miscellaneous reports and papers*

### **United States Department of the Interior, Office of Territorial and International Affairs**

1981

United States Department of the Interior  
Washington, D. C. 20240

*Assistant Secretary:* Vacant

This Office of Territorial and International Affairs is responsible for coordinating the international affairs of the United States Department of the Interior. The office analyzes, develops and reviews department policy programs and explores the opportunities for supporting United States foreign policy through its natural resource and environmental expertise.

### **United States Department of State (USDS)**

1980

2001 C. Street  
Washington, D. C. 20520

*Contact:* Bill L. Long, Director of the Office of Food and Natural Resources

The USDS promotes cooperative activities through the United States-Mexico Mixed Commission on Scientific and Technical Cooperation. The USDS also supervises the International Boundary and Water Commission.

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**United States Department of State, International Boundary and Water Commission, United States and Mexico (Comisión Internacional de Límites de Aguas, México y los Estados Unidos) (IBWC)**

1980

4110 Río Bravo  
El Paso, Texas 79902

*Commissioner:* Joseph Friedkin

Terrenos de Chamizal  
Ciudad Juárez, Chihuahua

*Commissioner:* Joaquín Bustamante Redondo

The IBWC works under the director of the United States Department of State and the Mexican Secretariat of Foreign Relations. Its responsibilities include implementing existing treaty provisions, improving water quality, preserving the international boundary and other water related issues concerning the two countries.

**Statutory State Commission, New Mexico-Mexico Border Commission**

1981

*Chairman:* Lewis R. Sadler  
Box 3JBR  
New Mexico State University  
Las Cruces, New Mexico 88003

**Sonora-Arizona Commission (Counterpart to Arizona-Mexico Commission)**

1980

Palacio de Gobierno  
Hermosillo, Sonora

*Chairman:* Governor Samuel Ocaña García  
*Executive Director:* Enrique Arturo Corella

**United States Department of State, United States-Mexico Mixed Commission on Scientific and Technical Cooperation**

The United States-Mexico Mixed Commission on Scientific and Technical Cooperation held its first meeting about agriculture in 1979. The Com-

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mission plans to develop jojoba, guayule, and other agricultural products and to promote cooperation in desertification and forestry. Studies suggested by the Commission include evaluations of different systems of establishing grasslands, the influence of diverse management practices and the productivity of forages, the development of improved varieties of native pastures of the arid areas, evaluation of introduced grasses and other related activities. The Commission includes representatives from CONAZA, CONACYT, CIQIA, the United States Department of Agriculture, and the United States Department of Commerce. Bilateral working groups are established as needed for joint program planning and coordination.

### **United States Geological Survey, Water Resources Division, Western Division**

1981

345 Middlefield Road  
Menlo Park, California 94025

The Water Resources Division of the United States Geological Survey conducts field studies in the arid and semiarid western United States with special emphasis on water resources.

### **United States Man and the Biosphere (MAB)**

1981

United States Department of State  
Washington, D. C. 20520

*Director:* Don King

MAB is an ongoing activity of the United Nations Educational, Scientific and Cultural Organization (UNESCO) studying biosphere reserves. One joint United States-Mexico project involves the Michilia, Durango, and Beaver Creek/Flagstaff, Arizona, areas, which have similar vegetation.

## **UNITED STATES RESEARCH INSTITUTIONS**

### **Arizona Agricultural Experiment Station**

1981

University of Arizona  
Tucson, Arizona 85721

*Director:* L. W. Dewhirst

Research activities of the Arizona Experiment Station emphasize problems unique to arid regions, including water conservation techniques on tradi-

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tional crops, the development of new crops such as jojoba and guayule, the improvement of water harvesting techniques and the development of alternative energy sources.

### **Arizona-Sonora Desert Museum**

1981

P. O. Box 5607  
Tucson, Arizona 85703

*Director:* Dan Davis

The Arizona-Sonora Desert Museum's research program includes a formal agreement with Mexico to breed the endangered Mexican wolf. Other breeding programs for endangered species from the Sonoran Desert region are in progress. Research on new arid lands crops is being pursued.

*Publications:* Annual report, quarterly newsletter, docent notes

### **Arizona State University**

1981

Tempe, Arizona 85281

*Director Engineering Research Center:* Charles Bockus

The Arizona State University was named as one of the responsible institutions to develop guayule, jojoba and candelilla as viable new crops for arid regions. The Engineering Research Center is particularly interested in land use and arid lands agriculture.

### **Arizona State University, Division of Agriculture, Center for New Crop Applied Science and Technology (NEWCAST)**

1981

Tempe, Arizona 85281

*Director:* Richard Chalquest

NEWCAST was established to develop new commercial crops from arid and semiarid land plants. Research activities have included studies of jojoba, guayule, winged bean and leucaena. Educational and training programs leading to the commercialization of these new crops are provided.

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### **Boyce Thompson Southwestern Arboretum**

1981

University of Arizona  
P. O. Box AB  
Superior, Arizona 85273

*Curator of Botany:* Frank S. Crosswhite

Research projects of the Boyce Thompson Southwestern Arboretum on ground covers, arid land legume trees and seed longevity are in progress.

**Publications:** *Desert Plants*

### **Chihuahuan Desert Research Institute (CDRI)**

1980

P. O. Box 1334  
Alpine, Texas 79830

*Director:* Dennis J. Miller

CDRI conducts educational and research programs to promote awareness of the Chihuahuan Desert. Past projects have included surveys and studies of Chihuahuan Desert fauna, groundwater geology and fire ecology.

**Publications:** *The Chihuahuan Desert Discovery*

### **Consortium for International Development (CID)**

1981

5151 E. Broadway Blvd.  
Tucson, Arizona

*Director:* John Fischer

CID is an organization of universities in the western United States. CID provides an interdisciplinary staff to work on problems involving arid land resources and the people who use them. Competencies include: research, information dissemination, technology transfer and technical assistance.

### **Desert Botanical Garden**

1981

P. O. Box 5415  
Phoenix, Arizona 85010

*Director:* Charles A. Hucking

Interests of the Desert Botanical Garden include desert trees and shrubs, and arid land horticulture and taxonomy.

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**Desert Research Institute (DRI)**

University of Nevada System  
Reno, Nevada 78507

*President:* Floyd P. Smith

DRI's Atmospheric Sciences, Water Resources, Energy Systems, Bioresources and Social Sciences centers conduct research related to the problems of arid zones.

*Publications:* Annual reports, technical reports, reprint series and newsletter

**International Center for Arid and Semi-Arid Land Studies (ICASALS)**

1981

P. O. Box 4620  
Texas Tech University  
Lubbock, Texas 79409

*Director:* Harold Dregne

ICASALS was created to identify, interpret and seek solutions to the problems of the world's arid and semiarid regions. Current research includes a program to increase production of sorghum and millet in Niger.

*Publications:* *Arid Lands Plant Resources*

**Native Plants Inc.**

1981

360 Wakara Way  
Salt Lake City, Utah 84108

*President:* G. Michael Alder

Present activities of the Native Plants Inc. include extensive research on tissue culture, production of plants for reclamation and resource assessments.

**New Mexico State University (NMSU)**

1981

Las Cruces, New Mexico 88003

NMSU's agricultural economics and agricultural business departments and Agricultural Experiment Station are studying the economic feasibility of developing crambe and other potential arid-land crops.

**Texas A & M University, Center for Strategic Technology,  
Texas Engineering Experiment Station**

1981

College Station, Texas 77843

*Contact:* Dan Bragg

Recent projects of the Center for Strategic Technology have included a study of the market potential of guayule.

**University of Arizona, Environmental Research Laboratory (ERL)**

1981

Tucson International Airport  
Tucson, Arizona 85706

*Director:* Carl N. Hodges

The ERL develops systems for increasing food supplies and conserving energy in the desert regions of the world. Projects have included research on the potential of halophytes as food and forage crops and use of the controlled environment greenhouse to farm shrimp.

**University of Arizona, Plant Sciences Department**

1981

College of Agriculture, Room 201  
Tucson, Arizona 85721

*Head:* LeMoyne Hogan

Plant Sciences Department activities have included research on buffalo gourd, jojoba, tepary beans and cotton.

**University of Arizona, Laboratory of Tree-Ring Research**

1980

College of Earth Sciences  
Tucson, Arizona 85721

*Director:* Bryant Bannister

Currently, the Laboratory of Tree-Ring Research is reconstructing past environmental conditions through precisely dated tree-ring chronologies.

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Through this study it is hoped that future climatic variations and the resulting impact on water supplies in the United States West may be anticipated.

Publications: *Papers of the Laboratory of Tree-Ring Research and the Tree-Ring Bulletin*

### **University of Arizona, Office of Arid Lands Studies (OALS)**

1981

845 North Park Avenue  
Tucson, Arizona 85719

*Director:* Jack D. Johnson

OALS is a research information center that addresses problems related to understanding, regenerating and developing the world's arid lands. Research topics include: economic botany, remote sensing, natural resources development and management, desertification, energy, technology transfer and land-use planning. As a clearinghouse for arid lands information, OALS provides specialized bibliographic searching and compilation, document translation and research support.

Publications: *Arid Lands Abstracts*, *Arid Lands Newsletter*, *Arid Lands Resource Information Papers*, annual reports and monographs

### **University of Arizona, Water Resources Research Center**

1981

A. E. Douglass Building, Room 102  
Tucson, Arizona 85721

*Director:* Sol D. Resnick

The Water Resources Research Center is an interdisciplinary organization concerned with water-related research investigations within the three state universities of Arizona. Investigations include water harvesting, evaporation suppression, seepage control and urban hydrology.

Publications: Published papers, annual reports and project completion reports

### **University of Texas, El Paso, Department of Geological Sciences**

1981

El Paso, Texas 79968

*Contact:* Robert H. Schmidt, Jr.

Climatological studies of the state of Chihuahua are being conducted in cooperation with the Escuela Superior de Agricultura, Hermanos Escobar.

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### **University of Utah, Geography Department**

1400 East 2nd South  
Salt Lake City, Utah 84112

*Contact:* Merrill Ridd

The University of Utah Geography Department worked with CIQA on an inventory of wild stands of guayule in Mexico.

### **COMMISSIONS**

Commissions were established to further good relations between the United States and Mexico and, in particular, the border states. Areas of interest include: tourism, agriculture and livestock, commerce and industry, banking and finance, education, public health, art and culture, and law.

#### **Arizona-Mexico Commission (Counterpart to Sonora-Arizona Commission)**

1981

Office of the Governor  
P. O. Box 13564  
Phoenix, Arizona 85002

*Chairman:* Governor Bruce Babbitt  
*Executive Director:* Antonio Certiosimo

#### **Commission of the Californias, State of California**

1981

107 South Broadway, Suite 4007  
Los Angeles, CA 90012

*Chairman:* Lieutenant Governor Mike Carb  
*Executive Director:* Leonard P. Breijo

#### **Good Neighbor Commission of Texas**

1980

Box 12007  
Austin, Texas 78711

*Chairman:* Manuel Jara  
*Executive Director:* Bob Watson

## APPENDIX B

### POTENTIAL CROPS

A brief discussion of some potential new crops is presented in the body of the text. This appendix lists some of the more promising arid-land plants that appear in the literature or that are currently being researched. This list indicates the wide variety of plants that are worthy of investigation and the number of products that might be derived from them. Included with the description of each species are references to more detailed discussions of the plant characteristics or the research that is being conducted.

#### *Acacia spp.*

[Duisberg and Hay, 1971]

Tannins are produced commercially from *Acacia decurrens*. Plantations of *A. decurrens* are maintained in its native Australia and in South Africa. The adult plant yields 20 to 25 kg. of bark. The bark is about 35 percent tannin. *Acacia* bark is one of the best and most important tanning agents.

Gums have been produced commercially from *A. senegal* in the Sudan and from *A. astragalus* in Iran. To date, gum production from arid-lands plants has depended greatly upon raw material harvested from wild stands.

#### *Agave spp.*

[Duisberg and Hay, 1971]

The *Agave* is the source of tequila and mescal. Its seeds are made into flour, and the blossom exudes a sweet nectar considered a rare treat by American Indians. The *Agave* probably has experienced the greatest economic and industrial development of any arid-land plant. The *Agave* may be the most utilized arid-land plant family. Species such as *A. sisalana* are cultivated extensively in Mexico, Haiti, Israel, Kenya, Mozambique, Cuba, Brazil, Indonesia, and Tanzania. The following excerpts from Duisberg and Hay (pp. 252, 248-249) indicate the extent of *Agave* use:

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"...Henequen from *Agave fourcroydes* is primarily produced in the Yucatan, Mexico. More than 100,000 hectares are in production in the Yucatan..."

"The average fiber production in the Yucatan plantations is about 1000 kilograms per hectare annually, or about 7 percent of the leaf weight. The juice and the bagasse remaining are used only for fertilizer. Considerable work has been done to try to develop products from other constituents, including the 0.2 percent of wax. In the case of *Agave sisalana* in Tanzania, the asponin hecogenin, a precursor of cortisone, is produced as a byproduct, even though the concentration in that species is low for the Agaves.

"Sisal is from *Agave sisalana*, also indigenous to Mexico, but interestingly enough, the plant is not grown there to any extent. It is, however, the principal hard-fiber desert plant grown in most other countries.

"The henequen and sisal industries are the largest and most advanced desert-plant industries. The United States, for instance, imports a total of 175,000 to 300,000 tons of fiber per year.

"The *Agave lechuguilla* is common in northern Mexico and western Texas of the United States in areas averaging 150 to 200 mm. of rainfall; it is the source of the hard fiber ixtle. The last attempt at industrialization of this resource failed in the United States about 1950. Mexican production has shown a downward trend.

"...In Mexico the alcohol tequila is made from *Agave tequilana* and the related species, and the alcohol mescal from *Agave atrovirens*. In both cases the central portions, or heads, are cooked in ovens to convert the glucosides into sugars. The juices are then extracted, fermented, and distilled. The distilling equipment is generally rudimentary and fiber is produced as a byproduct."

### *Amaranthus spp.*

[Felger, 1975 and 1979; Feine, et al., 1979]

Desert Indians have used the seeds and leaves of amaranth extensively. All amaranth seeds are edible and contain about 17 percent protein and 7 percent oil.

### *Amorpha canescens* (lead plant)

[Newton, et al., 1981; Foster and Brooks, 1981]

Under sponsorship from Exxon Enterprises, Texas A & M University has screened more than 2,000 plant species in a search for high biomass-producing arid land plants. *Amorpha canescens* is considered one of several potential species for energy crops on semiarid lands (see Table 2, from Foster and Brooks, 1981).

Table 2

## POTENTIAL SPECIES FOR ENERGY CROPS ON SEMIARID LANDS \*

Scientific Name	Common Name	Habitat <sup>2</sup>	Annual Biomass Production <sup>1</sup>		
			T/Ac/Yr	Btu./lb. <sup>3</sup>	MBtu./Ac/Yr
<i>Sporobolus airoides</i> (Torr.) Torr.	Alkali sacaton	Per Grass	0.5	6,200	6
<i>Asclepias latifolia</i> (Torr.) Rat.	Broadleaf milkweed	Per Herb	4.0	6,200	48
<i>Cenchrus ciliaris</i> L.	Buffalo grass	Per Grass	3.5	7,000	49
<i>Euphorbia antisiphilitica</i> Zucc.	Candelilla	Per Herb	1.0	7,000	18
<i>Bothriochloa turbinodis</i> (Lag.) Hertzer	Cane bluestem	Per Grass	1.5	6,300	19
<i>Sorghum halepense</i> (L.) Pers.	Johnson grass	Per Grass	3.0	6,500	41
<i>Kochia scoparia</i> (L.) Roth	Kochia fireweed	Ann. Herb	4.9	7,200	71
<i>Amorpha canescens</i> Pursh.	Lead plant	Per Shrub	—	6,000	—
<i>Baccharis halimifolia</i> Gray	Careless weed	Per Shrub	—	7,000	—
<i>Leucadenia retusa</i> Gray	Lead tree	Per Shrub	—	7,200	—
<i>Prosopis glandulosa</i> Torr.	Mesquite	Per Tree	1.0	8,050	16
<i>Chrysothamnus nauseosus</i>	Rabbit bush	Per Shrub	—	7,200	—
<i>Sorghum alnum</i> Purodi	Sorghum alnum	Per Grass	2.0	6,300	27
<i>Helianthus annuus</i> L.	Sunflower	Ann. Herb	1.5	6,800	20

<sup>1</sup> Field dry conditions, 8-10 percent moisture, 15 in. - 20 in. annual rainfall.

<sup>2</sup> Ann-Annual.

<sup>3</sup> Whole Plant, from R. J. Newton, D. J. Reid and D. R. Shelton, 1981. Energy plantations in West Texas; Evaluation of plant species selected for biomass production in semiarid regions of West Texas. *Texas Journal of Science*.

\* SOURCE: For and Brooks (1981).

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### *Amsonia spp.*

[McLaughlin and Hoffmann, 1982]

The University of Arizona has identified eleven plants (including *Amsonia* spp.) with the potential to produce biocrude for \$ 15 per million Btu. or less. See Table 3 (from McLaughlin and Hoffmann, 1982) for an analysis of these potential arid land crops based on morphology, extractables, yields and costs.

### *Artemisia tridentata* (big sagebrush)

[Foster and Brooks, 1981]

Big sagebrush is the most widespread and common shrub of western North America. It is especially common in the Great Basin. This species covers approximately 226,000 square miles in the 11 western United States. It grows in a variety of soils on arid plains, valleys and foothills and on slopes from 1,600 feet to 11,200 feet.

Although it is tolerant of alkaline as well as acid soils, its optimum growth is in deep, fertile, alluvial loams. No biomass yields have been reported.

### *Asclepias spp.* (milkweed)

[Foster and Brooks, 1981; McLaughlin and Hoffmann, 1982]

Desert milkweed grows on dry slopes and coarse soil where water is available infrequently or on depressions where soil moisture is more enduring. The desert milkweed is a perennial herb with a deep root system penetrating 6 feet to 7 feet. Milkweed is estimated to yield 20 percent liquid hydrocarbons (dry weight) having heating values up to 15,000 Btu. per pound. Yields have been projected to approximately 18 tons per hectare annually. Species of interest include *Asclepias speciosa*, *A. subulata*, *A. erosa*, *A. latifolia*, *A. mexicana*, *A. eriocarpa*, and *A. albicans*. (See also Table 3.)

### *Atriplex spp.* (saltbush)

[Foster and Brooks, 1981]

The saltbush is one of many halophytes being studied for the possibility of growing food or forage crops with salt water or on salty lands. Some of these plants may have the ability to remove salts from the soil, thus they

Table 3

## PLANTS SELECTED BY ARIZONA CRITERIA: MORPHOLOGY, EXTRACTABLES, YIELDS, COSTS \*

Species	Morphology			Extractables			Yields		Costs	
	Habit	Type	Coll. No.	%CH	%EOH	KBtu./lb	Ton/ac	Bbl./ac	\$/bbl	\$/MBtu.
<i>Pedilanthus macrocarpus</i> Benth.	Shrub	L	2477	25.0	11.1	15.2	4.1	10.3	40	9.00
<i>Asclepias albicans</i> Wats.	Shrub	L	1963	14.0	20.4	13.1	5.1	12.3	39	10.30
<i>A. subulata</i> Decne.	Shrub	L	1986	9.3	22.2	12.2	4.3	9.5	44	12.60
<i>Chrysanthemum paniculatum</i> (Gray)	Hall	Shrub	R	2427	18.3	14.5	14.2	2.2	5.1	52
<i>C. nauseosus</i> var. <i>bigelovii</i> (Gray)	Hall	Shrub	R	2408	15.1	20.8	13.2	2.0	5.0	13.10
<i>Amsonia grandiflora</i> Alexander	Per.	L	2228	5.1	35.2	11.0	2.4	6.6	42	13.30
<i>Xanthocephalum gymnospermoideus</i>	Ann.	R	2345	12.1	14.8	13.4	4.1	7.7	53	13.60
(Gray) B. & H.										
<i>Amsonia hirtella</i> var. <i>polygonoides</i> (Woodson) Wiggins	Per.	L	2354	8.6	29.8	11.7	2.0	5.4	46	13.60
<i>A. kearneyana</i> Woodson	Per.	L	2178	5.2	30.6	11.1	2.4	6.1	46	14.30
<i>Asclepias erosa</i> Torr.	Per.	L	2499	13.0	10.8	14.1	4.6	7.6	59	14.30
<i>Grindelia camporum</i> Greene	Bienn.	R	2390	13.0	11.8	13.9	3.8	6.6	58	14.50

All collection numbers are those of S. P. McLaughlin; voucher specimens are deposited at Arizona.

NOTE: Ann. = annual

Per. = herbaceous perennial

Bienn. = biennial

L = latex bearing

R = resinous

\* SOURCE: McLaughlin and Hoffmann (1982).

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may serve the dual purpose of reclamation as well as production of food or fodder.

### *Baccharis havaudii* (careless weed)

See Table 2.

### *Bothriochloa turbinodis* (cane bluestem)

See Table 2.

### Cactus Family

[Coyle and Roberts, 1975; Duisberg and Hay, 1971]

The cactus family includes several thousand species. Coyle and Roberts prepared a guide to plants of the Baja California region that offers brief explanations regarding uses of arid-zone plants. For example, the fruits of the *Ferocactus* genus (barrel cactus) can be fried or stewed and eaten. The pulp of the stem can be chewed for its water content. Indians used the barrel cactus as cooking pots by cutting off the tops, scooping out the pulp, and placing hot stones into the cavity to heat food.

Peasant peoples in Mexico and many areas of North Africa and the European Mediterranean depend on the "tunas", or fruit of *Opuntias* as a major source of carbohydrates and vitamins. In the 1960s a comprehensive scientific study of *Opuntias* was initiated in Mexico to produce high-quality edible fruit and tender pads for vegetables, and forage. Results indicate that 8 tons per hectare\* of fruit are possible with about 700 mm. of precipitation annually.

The large columnar cactus category includes *Carnegiea gigantea* (seguaro), *Lemaireocereus thurberi* (organ pipe cactus), and *Pachycereus pringlei* (cardon), the largest cactus in the world, growing to heights greater than 15 m. While these giant species are very interesting and their fruits and seeds often are consumed by humans, slow growth and large size may prevent domestication.

*Machaerocereus gummosus* (pitahaya agria), a cactus of Mexico's Baja California and coastal Sonora, bears fruit along its stems. The fruit is about the size of a small apple and covered with spines that tend to fall off when the fruit is fully ripe. The pulp is usually bright crimson-red, very juicy and both sweet and tart. Pitahaya agria is considered to be among the more delicious fruits of the world. The pulp formerly was used for making wine.

### *Cenchrus ciliaris* (buffalo grass)

See Table 2.

*Ceratonia (carob tree)*

[CONAZA, 1976]

The Comisión Nacional de las Zonas Áridas (CONAZA) reported planting 4,000 *Ceratonia siliqua* (carob tree) near Ensenada, Baja California, about 12 years ago. Although yield data were not given, carob pods from these stands are being marketed as a chocolate substitute and as an ingredient in flour formulations.

*Chrysothamnus nauseosus (rabbit bush)*

See Table 3.

*Chrysothamnus paniculatus*

See Table 3.

*Cucurbita foetidissima (buffalo gourd)*

[Bemis, et al., 1978 and 1979; Waymack, et al., 1976]

Potential uses of *Cucurbita* species include the production of edible oil and protein by-products from the seed, industrial starch from the roots, and forage from the vines. The species most often discussed are *C. foetidissima* (buffalo gourd), *C. digitata*, *C. palmata* (coyote melon) and *C. pepo*, all of which may provide good economic returns. A major effort to domesticate *C. foetidissima* and to industrialize its production is being undertaken at the University of Arizona. We report some of this work here.

The plant is perennial, reproduces asexually, grows as a weed in regions where rainfall is limited, and produces a large crop of seeds rich in oil and protein. The roots may weigh up to 50 kg. after three or four seasons of growth. They are mostly starch that can be hydrolyzed chemically or enzymatically to glucose (dextrose) for use as a sweetener in foods and beverages. The vines grow along the ground and because of their protein content (10 percent to 13 percent) and digestibility, they may have value as forage.

The oil of the seed has a high ratio of unsaturated to saturated fatty acids that makes it attractive for possible use in foods prepared for human consumption. Linoleic acid, an essential fatty acid in the diet of humans and animals, is present in amounts ranging from 50 percent to 60 percent. Incorporation of the crude oil into the diet of weanling mice in amounts up to 11 percent of the total diet produced excellent growth with no evidence of deleterious effects.

A crude oil can be extracted from the seed by a solvent process or by mechanical pressing. The remaining seed meal, which contains about 45

percent protein and 45 percent fiber, may be used in raw form as a component of animal feeds. Studies with rodents show that the protein quality of seed meal from *C. foetidissima* is similar to that of soybean and cottonseed meal.

Results of analysis of whole seeds show the presence of 32.9 percent crude protein and 33.0 percent crude fat. With seed yields of up to 3,000 kg. per hectare, *C. foetidissima* produces 1 ton of vegetable oil and 0.5 tons of protein. Also, an estimated 13.5 tons of crude starch per hectare could be produced every three years.

#### *Dunaliella spp.*

[Kessler, et al., 1981; Ben-Amotz, 1980]

*Dunaliella* is an algal genus that is cultivated for the production of chemicals, and has potential to yield other substances including fuel and petroleum-replacement products. The primary product yielded by *Dunaliella* is glycerol. It can constitute up to 85 percent of the alga's dry weight and is useful in further biocorversions to produce a variety of product mixes including thermoplastic resins. The algal biomass also may be converted directly into high quality liquid fuel by means of a simple extraction process. Specialty products for which *Dunaliella* is being cultivated commercially include —carotene, thiamine, vitamin B<sub>12</sub>, and high-quality protein that can be used for animal feed.

A major motivation for our involvement in this research is the suitability of *Dunaliella* for commercial culture in arid regions. The genus is highly tolerant of heat, and its salinity tolerance has been demonstrated to be between the values of 0.2 M and saturated NaCl. It does not require vitamins or soil extract for growth as do many other algae. *Dunaliella* is thus ideally suited for land-based culture in arid regions where saline water is available from mining, geothermal wells, and as a byproduct of conventional irrigation agriculture. Many of these waste-water sources are being investigated as *Dunaliella* culture media. Integration of algae culture into a water reuse scheme will augment further the positive environmental impact, and will improve the economics and energy balance of the system.

#### *Ephedra spp.*

[Caldwell, 1965]

Several arid-land plant species have been used to produce medicines, including ephedrine made from the genus *Ephedra* for commercial sale. In China and Pakistan, *E. sinica* and *E. gerardiana*, respectively, have been used to produce ephedrine in large volumes.

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### *Euphorbia antisyphilitica (candelilla)*

[CONAZA, 1976]

About 2 percent of the *Euphorbia antisyphilitica* plant is candelilla wax. Demand for this hard wax (melting point 67.5 C.) has ranked second to that for wax from carnauba palms, principally for use in floor polishes.

### *Euphorbia hirta*

[Caldwell, 1965]

*Euphorbia hirta* is a plant used in the manufacture of drugs to treat asthma and bronchitis.

### *Euphorbia lathyris (gopher plant)*

[McLaughlin and Hoffmann, 1982; Johnson and Hinman, 1980]

*Euphorbia lathyris*, the gopher plant, is one of several plants being studied to determine and to maximize its "biocrude" yield. Biocrude is the term coined at the University of Arizona to define the hydrocarbon and hydrocarbon-like substance extracted from plants. The biocrude may be cracked into gasoline or its constituents may be used as higher value petrochemical feedstock.

A research program to explore further these possibilities began July 1978 at the University of Arizona. Seeds of *E. lathyris* have been collected from around the world and are being propagated to select the most productive strains. Experiments have been initiated to determine nutritional requirements and optimal growing conditions for *E. lathyris* and to identify those factors responsible for hydrocarbon production in the plant. Various agro-nomic aspects are being evaluated.

Early growth data, developed through field-plot studies, are inconclusive with respect to potential biocrude yield. Nonetheless, we estimate that under proper cultivating conditions including irrigation, existing strains of *E. lathyris* annually will produce more than 14 barrels of biocrude per hectare each year.

### *Grindelia camporum*

See Table 3.

### *Helianthus annus (sunflower)*

See Table 2.

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*Kochia scoparia* (*Kochia fireweed*)

See Table 2.

*Larrea tridentata* (*creosot bush*)

[Duisberg and Hay, 1971; Timmerman, 1977; Foster and Brooks, 1981]

Creosote bush is one of the most abundant and widespread shrubs of the Sonoran, Chihuahuan, and Mojave deserts. It persists in regions with annual rainfall ranging from 4 inches to 20 inches. It grows on deep, alluvial soil, on the edges of alkaline flats, on sandy plains, and on the rocky slopes of volcanic hills. In general, total shrub biomass increases with rainfall. Annual biomass yields range from 1 dry ton per acre with 6 inches of natural rainfall to 5.7 dry tons per acre with 16 inches of natural rainfall. Creosote bush is well adapted to drought conditions.

The practical uses of creosote bush have been reviewed by Timmerman. Creosote bush is used as a whole plant as a livestock feed, as a medicinal plant, as firewood and as a roofing material. Creosote bush has many phenolics, volatile oils, waxes, saponins and free steroids. Creosote leaves and twigs possess approximately 16 percent resin.

*Leucaena retusa* (*lead tree*)

See Table 2.

*Parthenium argentatum* (*guayule*)

[Foster and Brooks, 1981; Foster, et al., 1979; CONACYT, 1978;  
McGinnies, 1979]

Guayule is an arid-adapted plant with a substantial history of commercial production. It is native to the Chihuahuan Desert of northern Mexico and southwestern Texas in areas that have annual precipitation of 16 inches or less. Guayule is a bushy, perennial shrub that grows to about 2 feet in height. The plant has an extensive root system that may spread 10 feet laterally and that may penetrate depths of more than 20 feet.

The primary product derived from guayule is rubber. By-products include resins that may prove to have substantial economic value as a petrochemical feedstock. Guayule, under irrigated conditions, has yielded as much as 23 percent (dry weight) resins, waxes, oils, etc. (acetone-benzene extracts). The bagasse, or plant residue from processing, may be used as a solid fuel for direct sale or cogeneration.

United States Forest Service Emergency Rubber Project (ERP) personnel planted 32,000 acres of guayule during World War II to offset wartime loss of *Hevea brasiliensis* (rubber tree) rubber imports. The ERP survey of the United States Southwest indicated that 37 million acres in California, Arizona, New Mexico and Texas were technically suitable for guayule production.

Commercial production of guayule rubber will result in significant quantities of plant matter available for a fuel. Each ton of extracted guayule rubber produces about 2 dry tons of wood fiber, 0.5 dry tons of resin, and about 1 dry ton of leaves.

In 1973 the Comisión Nacional de las Zonas Aridas (CONAZA) began a guayule research and development project. A rubber research production program was established in 1976. An extraction plant in Saltillo, Coahuila, México, has begun small-scale processing of material harvested from wild stands of guayule. CONAZA estimates that a full-scale extraction plant can produce 30,000 tons of rubber annually from wild guayule plants growing in the Mexican desert regions.

An increasing number of organizations and individuals throughout the world, especially in Mexico and the United States, are studying the technology of growing and processing guayule. However, little attention has been paid to the social, economic, and political consequences of further developing the technology. A comprehensive technology assessment (TA) of the effect of guayule commercialization in Mexico is underway as a joint project between OALS and the Centro de Investigaciones en Química Aplicada (CIQA). This TA examines the technical, economic, social, and political forces that might stimulate or inhibit the development of a guayule rubber industry, the impacts or consequences that this commercialization might bring, the alternative approaches that are open to government and the private sector, and the consequences that might be expected from following various policy options. Funding is provided by National Science Foundation and Consejo Nacional de Ciencia y Tecnología (CONACYT).

*Pedilanthus macrocarpus*

See Table 3.

*Phaseolus acutifolius* (*tepary bean*)

[Nabhan and Felger, 1978; Felger, 1978]

Teparies are leguminous annual plants of the *Phaseolus* genus. Many species produce edible beans containing about 30 percent protein. Tepary beans have been harvested from both cultivated and wild populations. Because teparies grow quickly and require little supplemental water, they should be considered a potential arid-land field crop.

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*Pinus eldarica* (Mondale or Afghanistan pine)

[Weber, 1981]

Many plants growing in arid lands are or have been used for cooking or as heating fuel, but often their use has led to environmental problems. Destruction of tree stands disturbs the habitat and hydrological regime. Soil stripped of plant cover becomes eroded, and desertification occurs. While there is great potential for use of trees such as *Acacia*, mesquite, and desert ironwood for fuels, their use can be successful only when cropping is accompanied by an appropriate reforestation program. *Pinus eldarica* is receiving considerable research attention because of its tolerance to high temperature as well as its rapid growth rate.

*Prosopis* (mesquite)

[Foster and Brooks, 1981; Felker, 1979]

Mesquite is a thorny, deciduous, large-crowned and deep-rooted shrub or tree growing up to 30 feet in height, depending on the variety and site. It is a native of the United States Southwest, Mexico, Africa, Venezuela and Colombia. Mesquite grows on a variety of soils and does well on sandy soils. Required annual rainfall is from 6 inches to 24 inches. Mesquite's woody habit and long tap root contribute to the plant's ability to withstand drought. Mesquite stands have been reported thriving in a chloride-plus-sulfate groundwater concentration of 6,600 ppm. Felker suggests this kind of tolerance makes mesquite a good candidate for the use of spent power plant cooling water in portions of the United States Southwest.

Mesquite has been used historically for fuel in all four continents in which it is presently found. Some mesquite species have annual timber yields of 1.3 to 3.5 dry tons per acre. If mesquite's annual above-ground timber volume yields 1.8 dry tons per acre in regions of 10 inches annual rainfall as reported, then total annual potential wood production of about 5.2 dry tons per acre is implied from mature trees under the same rainfall.

*Prosopis* (mesquite) beans were and in some areas still are the staple in the diet of many North and South American Indians; however, mesquite is considered a pest in many parts of the southwestern United States. Its control has been the object of much research in this country, even though a related species is cultivated in South America for cattle food.

*Rumex hymenosepalus* (canaigre)

[CONAZA, 1976]

Tannins are produced commercially from *Rumex hymenosepalus* (canaigre). Mexico hopes to provide all of its leather tanning needs by planting 2,000

hectares of canaigre. Preliminary research in Mexico indicates a yield of about 40 tons per hectare.

*Salsola kali* (*tumbleweed or Russian thistle*)

[Foster, et al., 1980; Karpiscak, et al., 1981; Hageman and Fowler, 1977]

One particularly innovative approach to the production of solid fuels in arid lands is the use of Russian thistle (*Salsola kali*), a weed accidentally introduced into the United States late in the 19th Century. Russian thistle germinates quickly on disturbed soils, has a high water-use efficiency, and is relatively free from diseases and parasites.

Research conducted at the University of Arizona Bioenergy Research Facility (BRF) has demonstrated that Russian thistle can be harvested with commercially available equipment. Yields of natural stands growing on retired farmland near the City of Tucson have averaged 1.0 to 1.5 tons per acre per year. In New Mexico, fertilized and irrigated stands harvested twice annually yielded 4.5 tons per acre per year.

BRF staff have harvested approximately 50 tons of biomass and converted it into modules, cubes or bales. Preliminary tests in residential fireplaces and woodburning stoves have indicated excellent burning time and heat production from manufactured Russian thistle logs (Tumblelogs). About 10,000 Tumblelogs are being distributed to the public for evaluation.

*Simmondsia chinensis* (*jojoba*)

[Sherbrooke, 1979; Sherbrooke and Haase, 1974; Yermanos, 1978; Hogan, 1979]

The jojoba shrub grows naturally in the Sonoran Desert of the United States and Mexico. Jojoba seeds contain about 50 percent oil by weight. Jojoba has appeared in the botanical literature since 1821. The earliest records of its uses are in correspondence from Eusebio F. Kino to King Phillip V dated 1701. Kino referred to the medicinal value of the fruit of jojoba, as did the Italian Jesuit Clavijero in 1789, who described a medicinal use of jojoba "berries". The oil expressed from jojoba seeds is similar to sperm whale oil. Jojoba seeds are harvested entirely from natural stands. Oil expressed from these harvested seeds is being sold in limited quantities for an average price of \$ 14 per kg. The oil content of the seeds does not decrease with long-term storage. Jojoba oil is remarkably resistant to bacterial degradation, probably because bacteria cannot cleave and metabolize the long-chain esters it contains, mostly hydrocarbons containing 38 to 44 carbon atoms.

Jojoba oil has potential uses as a fuel, as a chemical feedstock and, because it does not become rancid, as a replacement for vegetable oils in foods, cosmetics, and hair oil. The oil also can be a source of long-chain

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alcohols, anti-foaming agents, and lubricants. The hydrogenated oil is a hard, white crystalline wax. It has potential uses in making floor and automobile waxes, waxing fruit, impregnating paper containers, manufacturing carbon paper, and in making candles that have slow-burning and wilt-resistant qualities.

Approximately 1,500 hectares of commercially planted jojoba exist in California, 700 in Mexico, 400 in Arizona, and lesser amounts in Florida, New Mexico, and Texas. Jojoba also is grown commercially in Australia, Israel, Saudi Arabia, Iran, Egypt, Jordan, and Ghana. To our knowledge, no one affiliated with these plantations has reported yields of jojoba seeds, although we anticipate that yield data will be presented at the Fifth International Conference on Jojoba and Its Uses held in Tucson, October 11-15, 1982.

*Sorghum spp.*

See Table 2.

*Sporobulus airoides (alkali sacaton)*

See Table 2.

*Xanthocephalum gymnospermoides*

See Table 3.

*Yucca spp.*

[CONAZA, 1976]

CONAZA is conducting research on *Yucca*. A large *Yucca* industry is anticipated in Mexico based on uses of plant products such as chemicals, medicines, food, and alcohol. CONAZA has forecast an annual production capability in Mexico of 400,000 liters of candelilla, which can be used as a fruit-preserving emulsion. In 1975 to 1976, 10,000 liters of a candelilla derivative emulsion were produced and sold to preserve limes.

*Zostera marina (eelgrass)*

[Felger and Moser, 1973]

The sea grasses, of which there are about 50 species, thrive in the saline habitats of coastal deserts and in near-shore ocean waters and estuaries. The

seed of *Zostera marina* (eelgrass) was one of the most important traditional foods of the Seri Indians in northwestern Mexico and is still harvested occasionally by them. Its seed has about 13 percent protein and 50 percent protein starch.

*Other Species*

The ethnobotany of many other plants has been reported in the literature. Arid land plants have been used for construction, arrows, fishhooks, drills, flutes, dyes, medicines and hallucinogens. We have not attempted to list all plants with known uses, rather we have prepared a representative list to indicate the direction of some research and the obvious need to do more.

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# LOS RECURSOS NATURALES BIÓTICOS EN EL MARCO DE LA ECOLOGÍA TRANSFRONTERIZA DE MÉXICO Y EE.UU.

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## PRÓLOGO

La intención de estas notas es esencialmente invitar al lector a una reflexión sobre algunos de los interrogantes que plantea esa faceta emergente de la ecología que se refiere a los problemas de recursos naturales entre países. Para ello centramos el análisis en algunos recursos bióticos comunes. Pretendemos también llamar la atención sobre la necesidad de elaborar una Teoría Ecológica Transfronteriza que proporcione el marco adecuado a los convenios, programas y acciones que para el caso se emprendan bilateralmente. Nuestra intención no es usar la retórica catastrofista usual que busca horrorizar con las consecuencia de los pecados contra el equilibrio de la naturaleza para conmover al interesado; este tipo de mensaje a estas alturas hace tan poco efecto contra el pecado como los sermones de domingo. No sorprende dicha ineficacia pues en gran medida los problemas del medio ambiente tienen implicaciones profundas de índole política, social e históricamente predeterminadas. No son exclusivamente problemas técnicos.

La ecología es una ciencia o conjunto de ciencias que apuntan a la comprensión de las interrelaciones entre los seres vivos y el mundo que los rodea, lo cual subsume el rol del hombre.<sup>1</sup> La ecología entonces es una ciencia totalizadora, o interdisciplinaria como se diría hoy en día, no siendo recomendable abordar los problemas en forma aislada, ya que, aunque se haga de manera correcta, se corre el riesgo de perder la visión de conjunto. Es más, a 123 años de Darwin no es justificable fácilmente que el hombre se sitúe frente a la naturaleza como algo distinto a ella, debe incluirse como uno de los tantos hilos en la compleja trama de la vida en la tierra. Revisando uno de los textos más

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<sup>1</sup> R. J. BENNET y R. J. CHORLEY, *Environmental Systems: philosophy, analysis and control*, London, Methuen and Co. Ltd., 1978.

populares en este campo<sup>2</sup> entresacamos componentes de por lo menos las siguientes áreas: biología, demografía, química, matemática, física, termodinámica, oceanología, minería, climatología, genética, fisiología, bioquímica, epidemiología, agronomía, geofísica y varias más. Por esto difícilmente se puede dar a la ecología una sola visión. Pese a los biólogos que reclaman el derecho a la paternidad, esa visión integral que es la ecología puede obtenerse bajo distintas ópticas.

Si bien nuestro análisis se refiere a la situación de los recursos naturales bióticos, hemos procurado no hacer un análisis muy reduccionista de manera que se pueda, en la medida de lo posible, integrar al conjunto de los análisis que presentarán otros investigadores en esta reunión y que cubrirán aspectos importantes como son los atmosféricos, los hidrológicos, los sociales y demás.

#### *Vegetación y Fauna: Esbozo de Inventario*

La zona fronteriza del norte de México con los Estados Unidos está representada por 6 de las 32 entidades federativas que integran la República Mexicana. Dichos 6 estados ocupan el 40% del total de la superficie de nuestro país. La colindancia fronteriza en los E.U.A. se da a lo largo de 3,326 km. del área continental terrestre. Dicha franja de terrenos en el hemisferio norte del continente reúne características tales que permiten una gran diversidad ecológica. Esta diversidad se da por la ubicación geográfica de la franja en los límites del Trópico de Cáncer, por lo accidentado de la fisiografía producto de una historia geotectónica activa, por la situación entre las dos mayores masas oceánicas del planeta que ejercen una influencia climática acentuada, y por el carácter de transición entre las dos grandes regiones biogeográficas, la Neártica y la Neotropical.

Los climas dominantes son los desérticos y esteparios caracterizados por la escasez e irregularidad en la distribución de las lluvias y períodos de sequía que se pueden alargar por 7 a 11 meses. Reyes<sup>3</sup> ha dividido la zona fronteriza en cinco provincias bióticas principales que analiza con detalle en un trabajo reciente:

1. *Provincia biótica californiana*, situada en la parte noroeste del Estado de Baja California Norte, sobre las sierras de Juárez y de San Pedro Martir.

<sup>2</sup> P. H. ERLICH, A. H. ERLICH y J. P. HOLDREN, *Ecoscience: population, resources, environment*, San Francisco, Freeman and Company, 1977.

<sup>3</sup> P. REYES, *El escenario ecológico del norte de México*, trabajo no publicado, 1980.

2. *Provincia biótica sonorense*, que ocupa gran parte de la península de Baja California y las partes bajas de Sonora. Coexisten en ella especies boreales y tropicales aunque dominan las segundas, adaptadas a las condiciones de sequedad.
3. *Provincia biótica chihuahuense*, en la parte septentrional del Altiplano mexicano entre las sierras Madre Occidental y Oriental de los Estados de Chihuahua, Coahuila, Nuevo León y Tamaulipas. Se extiende hacia los E.U.A. y el norcentro de México. Tiene abundancia de plantas y de animales. Flora y fauna de afinidades tropicales y boreales templadas.
4. *Provincia biótica tamaulipecana*, se localiza en las partes bajas al sur del Río Bravo de los estados de Coahuila, Nuevo León y Tamaulipas. Es menos árida que las anteriores y un activo corredor de fauna y flora con el sur y sureste de E.U.A. Es área de sustento para migraciones de aves.
5. *Provincia biótica de la Sierra Madre*, que ocupa los sistemas montañosos, la Sierra Madre Occidental en los estados de Chihuahua y Sonora y la Sierra Madre Oriental en los de Coahuila, Nuevo León y Tamaulipas. Se caracteriza por su variación en humedad y diversidad de altitudes. Flora y fauna relacionadas con la boreal o templada del norte; muchas variaciones y adaptaciones.

Para dar idea general de la riqueza botánica de México, puede señalarse que con más de 20,000 especies probables de plantas vasculares, México tiene una flora más vasta que la de la Unión Soviética y del mismo orden que la de E.U.A. y Canadá juntos. Sin embargo, en lo general, son más las semejanzas que vinculan a la vegetación de México con la del Oeste, que con la del Este de E.U.A. por causas evidentes de 1) Colindancia directa, 2) Semejanzas fisiográficas y 3) Semejanzas climáticas.<sup>4</sup>

Los ecosistemas más abundantes para cada provincia biótica pueden resumirse así:

#### *1. Provincia californiana*

- a) *Chaparral perennifolio*, formación única en México representada por diversos arbustos, matorrales, chamisos, encinos diversos y madroños.

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<sup>4</sup> J. RZEDOWSKI, *La Vegetación de México*, México, Limusa, 1980.

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b) *Bosques de encino*, en las laderas de las sierras con predominio de especies arbóreas de encinos, enebros y madroños.

c) *Bosque de pino-encino*, en las partes altas y laderas más húmedas, diversas clases de pinos, cedros y encinos.

La fauna propia de la provincia es escasa en vertebrados siendo los más característicos la codorniz de montaña y la ardilla aunque se encuentran también codorniz, huilota, torcaza, liebre, conejo, tlalcoyote, zorillo, puma, gato montés y, todavía, venado bura. El cóndor de california está en vías de extinción y el oso plateado se ha extinguido por completo. Existe también una diversidad de aves migratorias que invernan en esta área como el ganso de collar, el pato boludo, el pato chillón y la negreta.

### 2. Provincia sonorense

a) *Matorral desértico*, muy extendido y con gran número de variantes. Se encuentran gobernadora, ocotillo, magueyes, nopales, varias cactáceas, palma, jojoba y otras.

b) *Mezquital*, en amplias extensiones dominan el mezquite, huamúchil y otras leguminosas, pastos y herbáceas anuales.

c) *Manglar*, ocupa áreas muy localizadas, con mangle rojo y botoncillo.

d) *Selva baja caducifolia*, formación característicamente tropical que alcanza su límite norte en Sonora y Baja California; encuéntrase en lugares más húmedos y cañadas, la ceiba y las burseras.

La fauna incluye liebre, ardillas, rata almizclera, codornices, tortuga, nutria y zorra. También algunas especies tropicales como tlacuache, armadillo, tejón, jabalí, chachalaca, tigrillo y jaguar. Los grandes mamíferos como el venado cola blanca, el bura, el borrego cimarrón y el berrendo aún existen, pero están sujetos a fuerte presión antropogénica y amenazados de extinción. Otras especies presentes en esta provincia son el coyote, la zorra, el cacomixtle, el mapache, los zorrillos y el puma.

En esta provincia todavía se encuentran animales con afinidad boreal, que alcanzan su límite sur en ella, como los gansos, patos, grulla, y castor. Son muy numerosos los pequeños vertebrados como las serpientes de cascabel, lagartijas y roedores de los que existen una diversidad de especies.

### *3. Provincia chihuahuense*

a) *Matorral desértico*, que ocupa grandes extensiones, con algunas variaciones locales. Es característica la gobernadora, el guayule, la candelilla, la lechuguilla, el ocotillo, hojasen, nopales, garambullo, magueyes y numerosas cactáceas y herbáceas anuales.

b) *Pastizal*, es el área continua más extensa de México cubierta con esta formación natural. Dominado por gramíneas. Los zacates más característicos incluyen la navajita y cinco géneros más.

c) *Bosques de encino y/o pino*, existen en ciertas partes de la sierra de Chihuahua y Coahuila. Dominan los encinos con diversas especies así como enebros y pinos.

La fauna de esta provincia es semejante a la de la provincia sonorense, aunque tiene algunas características propias como la existencia de tortuga gigante y ausencia de animales más tropicales como el armadillo y el tlacuache. Como en otras provincias, se encuentran en ésta al límite de su extinción, el borrego cimarrón, el berrendo, el oso negro, y el lobo. Es notable también la regresión de aves migratorias acuáticas como los gansos, patos, gallaretas, grullas, como consecuencia de la desecación y desaparición de cuerpos de agua dulce.

Son característicos del área, la codorniz escamosa, la zorra norteña, tlacoyote, zorrillo, gato montés, los venados bura y cola blanca. También son de amplia distribución el coyote, puma, conejo, cacomixtle y liebre. Los pequeños vertebrados abundan, tales como serpientes, lagartijas y roedores.

### *4. Provincia tamaulipecana*

a) *Matorral espinoso*, dominado por mezquite, huizache, nopal, cactáceas, garambullo, yuca y palma. También huamúchil y en algunos lugares encinos.

b) *Selva tropical caducifolia*, formada por árboles que pierden sus hojas en la estación de secas y exuberante en la de lluvias. Dominan palo mulato, huamúchil y palo blanco.

c) *Manglar*, localizase al sur de Tamaulipas con el mangle rojo en su límite norte además de otros manglares.

Destaca en cuanto a la fauna, la penetración de especies típicas del trópico que alcanzan su límite norte. Se encuentra el hocofaisán, cojo-

lite, venado temazate, venado cola blanca, jaguar, jabalí y en las costas, las áreas de ovoposición de tortugas. Los numerosos cuerpos de agua dulce y salobres albergan una rica fauna de aves migratorias y residentes. Hacia el sur es notable la anidación de gran cantidad de pericos y cotorras.

### 5. Provincia de la Sierra Madre

a) *Bosque de encino*, característico de las montañas mexicanas que junto con los pinos dominan la Sierra Madre Oriental y abundan en la Occidental. Ocupan áreas tradicionalmente modificadas por el hombre dando lugar a formaciones secundarias como ciertos zacatales o matorrales y en casos extremos a terrenos agrícolas. Son dominantes los encinos de los cuales existen en México cerca de 200 especies.

b) *Bosque de coníferas*, son característicos de la Sierra Madre Occidental con notable diversidad. Existen abetos, enebros y pinos, de los que existen en México 35 especies. Dase mayor abundancia en los lugares más húmedos.

c) *Bosque mesófilo de montaña*, formación única en México con distribución discontinua a lo largo de la Sierra Madre Oriental y en áreas reducidas de la Occidental. Dominan árboles de hoja ancha que las pierden en la época fría como liquidámbar, álamos, encinos, nogales y otros. Con afinidades al bosque templado caducifolio del Este de E.U.A. y con abundancia de epífitas como orquídeas, musgos, helechos y bromelias. Ocupan la parte alta de la montaña donde las neblinas son comunes. El área que ocupan en Tamaulipas se extiende hacia Nuevo León.

La fauna de esta provincia biótica está representada por guajolote, codornices, ardillas, venado cola blanca, puma y gato montés. En aves, especialmente en la Sierra Madre Oriental, existe una gran riqueza que incluye pájaros carpinteros, guacamayas y palomas. El lobo y los osos negro y gris aún se conservan en algunos sitios de Chihuahua y Sonora, aunque sus poblaciones son escasas en extremo.

Obviamente no se ha podido cubrir en el inventario todos los recursos bióticos de interés para el norte del país; hemos dejado de lado en este breve trabajo a la fauna marina, que en los litorales del noroeste y del Golfo de México presentan características de excepcional diversidad;<sup>5</sup> como por ejemplo, en aguas aledañas a B. C. Tampoco nos

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<sup>5</sup> T. CASTRO, *Distribución Geográfica e Importancia de A. Salina en México*, reportes de Investigación, N° 6, México, Universidad Autónoma Metropolitana-Xochimilco, 1980.

referimos a la flora algal del mar, aún poco estudiada y aprovechada.\* No nos referimos tampoco a microorganismos marinos de potencial tecnológico previsiblemente rentable.<sup>6</sup>

### *Vegetación y Fauna: Esbozo de Diagnóstico*

Señala Rzedowski en su excelente obra que la flora de México aún no está bien estudiada y que el conocimiento de muchos grupos de plantas que la componen presenta deficiencias, sobre todo para ciertas partes del territorio de la República Mexicana; pero aunque el conocimiento de nuestros recursos vegetales es todavía incompleto, su importancia es esencial, junto con otras 10 zonas en el mundo, para explicar el origen y la domesticación de muchas plantas de uso humano y donde aún se encuentran los progenitores.<sup>7</sup>

La vegetación mexicana nativa de las zonas áridas y semiáridas es la que menos ha sufrido por efecto humano, excepto en las restringidas áreas de riego, las destinadas a la ganadería que en ocasiones están expuestas al sobrepastoreo propiciador de invasión de plantas leñosas y herbáceas que los animales no comen, que a su vez pueden traducirse en debilitamiento de la cubierta del suelo, facilitándose la erosión. El aprovechamiento de las plantas silvestres en algunas áreas ha causado ya modificaciones en la vegetación, como es el caso de la candelilla cuya abundancia ha disminuido notablemente en partes de Coahuila, por la explotación desmesurada; sin embargo, grandes extensiones del norte árido del país permanecen aún escasamente pobladas y sin uso alguno.\*

Reyes considera que también la creciente colonización urbana e industrial, la expansión agrícola y ganadera sofisticada, la explotación forestal y las actividades mineras han contribuido a una mayor degradación y perturbación de los ecosistemas naturales. Siendo así que los problemas más serios derivados de la acción humana incluyen la erosión, modificaciones al suelo, al régimen hídrico y consecuentemente al clima, hay evidencia de contaminación atmosférica y de corrientes de agua por efecto de pesticidas y otras substancias químicas que afectan diversos hábitats.

Mucho más grave, se ha señalado, es la situación de la fauna silvestre, que en términos generales se ha visto altamente afectada, ya

\* Ver nota 4.

<sup>6</sup> Interntl. Symp. on the Brine Shrimp, *Artemia salina*, Corpus Christi, E.U.A., 1979.

<sup>7</sup> O. FRANKEL, "Nuestra responsabilidad en la Evolución", *El Correo de la UNESCO* (París), Año XXXIII, mayo, 1980, pág. 25.

\* Sin embargo son los bosques tropicales los que mayores cambios han sufrido y que peligrosamente se agotan para dar paso a desmontes masivos, base para una hipotética avanzada agro-industrial.

que siendo la caza una actividad significativa en gran parte de los estados fronterizos, no se ha llegado todavía a una organización adecuada; esta actividad, al permitirse sólo a una élite económicamente fuerte<sup>8</sup> como caza deportiva, ha provocado una desvalorización total de la fauna silvestre, cuyo resultado se ha traducido en la desaparición de las especies más valiosas desde el punto de vista cinegético.

Pese a lo señalado en el sentido de que el norte del país aún presenta grandes extensiones sin desarrollo alguno, la realidad muestra que la dinámica de crecimiento de la región, por lo menos en lo urbano, es notoriamente espectacular,<sup>9</sup> donde las necesidades propias del desarrollo que tal crecimiento implica, no han sido obstáculo para que algunos estados del norte de México se planteen la conveniencia de un plan ecológico estatal.<sup>10</sup>

Nos atrevemos a decir que nunca se obra con demasiada cautela en materia de equilibrio ecológico, y cuando se plantea la conveniencia de intensificar esfuerzos para la explotación de la flora interfronteriza nativa,<sup>11, 12, 13</sup> uno se pregunta si esos planteamientos cuentan con el suficiente respaldo de estudios ecológicos.

Solamente el 0.6% de la superficie total de los estados fronterizos del norte de México están protegidos ecológicamente, lo cual está muy por debajo del 5% recomendado por organismos internacionales. En este contexto es relevante recordar el avance que los procesos de desertificación tienen en el mundo y en el país, precisamente en su porción norte. En efecto, al inicio de la colonización española los cronistas estimaban que el 50% del territorio mexicano eran bosques, selvas o florestas y en la actualidad lo es solamente el 10% y con características edafológicas generales de gran vulnerabilidad.<sup>14</sup> Como se sabe, el peligro de desertificación es más evidente y mayor el riesgo, en las franjas

<sup>8</sup> Nota del 7 de noviembre de 1981 en el periódico *Excelsior*, "Costarán 80,000 pesos a los cazadores nacionales y 10,000 dólares a los extranjeros los permisos para cazar borrego cimarrón adulto."

<sup>9</sup> Banco Nacional de Comercio Exterior, S. A., México 1976: *hechos, cifras, tendencias*, 7<sup>a</sup> edic., México, 1976.

<sup>10</sup> V. SUÁREZ, *Asesoría de Asuntos Ecológicos del Gobierno del Estado de Sonora*.

<sup>11</sup> Centro de Investigación en Química Aplicada, CIQA, *Reunión Internacional de Zonas Áridas*, Saltillo, México, 1980.

<sup>12</sup> *Underexploited Tropical Plants with Promising Economic Value*: Report of ad hoc panel of the Advisory Committee on Technology Innovation, National Acad. of Sciences, Washington, D. C., 1975; ver también: *Guayule, an Alternative Source of Natural Rubber*: Report of an ad hoc panel of the Board of Agriculture and Renewable Resources, National Acad. of Sciences, Washington, D. C., 1977.

<sup>13</sup> A. R. WILLIAMS, "Yucca: unappreciated, versatile tree", *R. and D.*, México, 1, N° 10 (1981), p. 27.

<sup>14</sup> J. LAHOUD, "Special Report: The Price of Development", *Ford Foundation Letter*, 12, N° 5 (1981), p. 3.

semiáridas y semihúmedas que rodean a los verdaderos desiertos del planeta,<sup>15</sup> y aunque las causas de la desertificación son múltiples, y algunas debatibles, destaca el rol que juega el abatimiento de la vegetación y el uso indebido del suelo o del cultivo. Por ello, frente al posible énfasis en proyectos de obtención de materias primas para los sectores modernos.<sup>16, 17</sup> ¿No sería interesante y prudente investigar con detalle otros aspectos que en México son prioritarios, como la alimentación? Toledo<sup>18</sup> recientemente refirió la experiencia local de seris, pimas y pápagos como una opción para las zonas áridas, en la cual se pueden explorar nuevas fuentes de alimento. Multitud de especies conocidas por grupos locales pueden ser la base para una agricultura integrada a la ecología de la zona; se mencionan el mezquite, el frijol tépari y numerosas frutas, raíces, semillas y tallos de la flora local. Solamente en el desierto sonorense se han registrado 375 especies, de las que destaca el uso seri de pastos marinos halófilos del Golfo de California, con un elevado valor nutritivo.<sup>19</sup>

Frente a las posiciones encontradas que suelen darse en ecología entre conservacionistas y consumidores del medio, es interesante referirse a la alternativa integral que ofrece el concepto de Reserva de la Biosfera. Promovido por el programa MAB de la UNESCO, dicho concepto ofrece una opción racional entre las posiciones todavía frecuentes del aprovechamiento ecológicamente irreflexivo para beneficio solamente del capital o la supervivencia y la conservación del medio totalmente al margen de la producción y del hombre mismo.<sup>20</sup>

<sup>15</sup> F. MEDELLÍN, *La Desertificación en México*, Instituto de Investigación de Zonas Desérticas, Univ. A. de San Luis Potosí, San Luis Potosí, México, 1978.

<sup>16</sup> J. D. JOHNSON y C. W. HINMAN, "Oils and Rubber from Arid Land Plants", *Science*, 208 (1980), 460.

<sup>17</sup> M. CALVIN y G. E. CALVIN, "Hidrocarburos de Plantas: Substitutos del Petróleo", Ciclo de Conferencias en el Centro de Desarrollo de Productos Bióticos y Escuela Nacional de Ciencias Biológicas del Instituto Politécnico Nacional, México, nov., 1981.

<sup>18</sup> V. M. TOLEDO, "Crítica de la Ecología Política", *Nexos*, 4:47 (1981), México, p. 17.

<sup>19</sup> A. A. LÓPEZ, *Cuerpo Humano e Ideología, Las Concepciones de los Antiguos Nahuas*, Tomo I, México, Universidad Nacional Autónoma de México, 1981, pp. 81 y 318. "Cuando los españoles arribaron al altiplano central quedaron admirados por la densidad de población en los valles. Más admirable es esta densidad si se toma en cuenta la falta de la rueda y de bestias de carga y tiro en el transporte. La explicación debe buscarse principalmente en dos factores: las particulares formas de organización de la fuerza de trabajo y el grado de aprovechamiento del medio ecológico que permitían obtener de él un rendimiento tan considerable... El ser humano concebía su propia naturaleza como una composición inestable cuyo ideal era el perfecto equilibrio... el esfuerzo del individuo lo conducía a la armonía con el cosmos."

<sup>20</sup> E. BELTRÁN, *La Deterioración del Ambiente: enfoque ecológico*, Instituto Mexicano de Recursos Naturales Renovables, México, 1971.

Dicho concepto está siendo desarrollado y adaptado a las necesidades de México por el Instituto de Ecología en cooperación con diversas instituciones y organismos y en estrecha relación con los gobiernos de dos estados del norte del país como son Durango y Sonora. El concepto se utiliza con base en los siguientes postulados, *a)* protección del germoplasma, *b)* vinculación sin contraposición, de las necesidades humanas con los principios de la conservación, *c)* la conservación de comunidades vegetales y animales en el contexto ecológico, y *d)* el mejoramiento de la calidad de vida del hombre, adicionalmente, el concepto de Reserva de la Biósfera se basa en el marco integrado de la cooperación voluntaria de los habitantes y productores de la región, de la investigación y la docencia de nivel terciario con los programas de desarrollo a niveles nacional e internacional.<sup>21, 22</sup>

Sin suscribir una posición de conservadurismo ecológico a ultranza, enfatizamos que la prudencia en materia de ecología se requiere no sólo por las consecuencias posibles a nivel local, sino por las consecuencias globales que pueden presentarse. Consecuencias que pueden darse a distancia. Basta recordar el ya célebre y lamentable caso relativo a la salinidad del Río Colorado, que en su hontanar corre con agua cristalina de la montaña y llega a depositar, en su desembocadura, a muchos kilómetros de ahí y en otro país, no sólo agua inservible para la agricultura sino parte de los problemas ecológicos de las pesquerías de la zona norte del Golfo de California.<sup>23</sup> En palabras del autor de un artículo reciente sobre este problema específico, se nos indica que fue el aprovechamiento del agua para riego en el Valle Wellton-Mohawk y para “llenar albercas en California” lo que “quebró la espina dorsal del Río Colorado”.<sup>24</sup> El problema adicional que representan la contaminación por pesticidas y desechos radiactivos es también muy preocupante, y debe ser investigado a fondo.<sup>25</sup> Evidentemente los problemas ecológicos viajan grandes distancias y son insensibles a la existencia de fronteras políticas.

<sup>21</sup> M. MALDAGUE, “Le Concept de Reserve de la Biosphère, son implantation et sa vocation entant q'instrument pour le développement intégré”, UNESCO, Progr. sur l'homme et la Biosphère (MAB), Quebec, 30-VI-81; ver: G. HALFFTER, “Reservas de la Biósfera y Parques Nacionales: dos sistemas complementarios de protección de la Naturaleza”, en Impacto-UNESCO, 30:4 (1980), p. 39. Los programas MAB-UNESCO de México y E.U.A. están en colaboración para el abordaje de varios problemas ecológicos de interés mutuo.

<sup>22</sup> “Man and the Biosphere”, AMBIO, Special Issue, X, Nº 2-3, Royal Swedish Academy of Sciences, Stoccolm, 1981.

<sup>23</sup> J. J. MORALES, “El Ocaso de la Totoaba”, *Técnica Pesquera*, Año XIII, Nº 150 (1980), México, p. 16.

<sup>24</sup> J. BOSLOUGH, “The Tortuous Course of the Colorado”, *Science*, 81, 2:5 (1981), 30.

<sup>25</sup> Nota del 9 de enero de 1982 en el diario UNOMASUNO, “La radioactividad del Colorado ¿un peligro para México?”

Es necesario enfatizar en este punto la conveniencia de llevar a cabo estudios sistemáticos interdisciplinarios sobre posibles efectos del deterioro ambiental localizado y sus alcances regionales y mundiales para las comunidades bióticas. Ejemplo en este sentido es el caso del daño a ecosistemas lacustres y boscosos de los países escandinavos, por el deterioro generado a muchos kilómetros de ahí, precisamente en los países del norte de Europa, desde Gran Bretaña hasta Polonia.<sup>26</sup> Otro caso semejante, que puede ser objeto de estudio es el de la lluvia ácida en el noreste de E.U.A. y sureste del Canadá.<sup>27</sup> En ambos casos los vientos dominantes superficiales arrastran los contaminantes, producto de la intensa actividad fabril y urbana, de un lugar hacia otro. Aunque con carácter de accidente y no de un flujo continuado sistemáticamente por años, sería en este tipo de problemas interpaíses y a distancia, en que habría que inscribir casos como el del Ixtoc,<sup>28, 29</sup> en ocasiones considerado bajo una óptica peligrosamente ingenua y totalmente fuera de contexto.<sup>30</sup> Otro caso semejante, objeto posible de análisis, podría ser el efecto de la intensa actividad industrial y urbana en el corredor Los Ángeles, E.U.A.-Tijuana, Méx. y sus efectos posibles no sólo en la flora y fauna circunvecina sino quizás para la misma salud humana.<sup>31</sup> A la luz de la fragilidad de algunos suelos de la franja fronteriza, este tipo de estudios podría extenderse hasta el sureste de Texas y noreste de México, zona intensamente productora de gas y petróleo,<sup>32, 33</sup> y significativo corredor para la migración de numerosas especies de plantas y animales,<sup>34, 35</sup> que pueden verse afectados por la creciente actividad industrial de esa zona.

<sup>26</sup> Air pollution across national boundaries: The impact on the environment of sulphur in air and precipitation. Royal Ministry of Foreign Affairs, Stockholm, 1971.

<sup>27</sup> A. LABASTILLE, "How Menacing is Acid Rain?", *Natl. Geographic*, 160: Nº 5 (1981), 652; ver también nota 50.

<sup>28</sup> L. GARMON, "Autopsy of an oil spill", *Science News*, 118: Nº 17 (1980), 267.

<sup>29</sup> Varios autores, "Pesca y Petróleo", en *Técnica Pesquera*, Año XII, Nº 139, 1979.

<sup>30</sup> "Ixtoc's Intox", en *Calypso Log*, 1: Nº 7 (1979). Órgano de la Cousteau Society, N. Y.

<sup>31</sup> S/N MUSSEL, "Bound Monitors", *Science News*, 118: Nº 17 (1980), 270; ver también A. VALADÉS TORRES y S. P. VALDERRAMA, "Programa Nacional de Certificación Sanitaria de Moluscos Bivalvos", en *Resúmenes del VI Congreso Nacional de Oceanografía*, U.A.B.C., Ensenada, 1978.

<sup>32</sup> Cómo es México, Serie Manuales de Información Básica de la Secretaría de Programación y Presupuesto, México, 1979, p. 87.

<sup>33</sup> "Energy, Special Report", *National Geographic*, febrero, 1981.

<sup>34</sup> P. REYES, "Aves Migratorias de la Región de Laguna Verde", trabajo inédito; ver también, "Bird Migration", *Natl. Geographic*, 156:2 (1979).

<sup>35</sup> H. D. THOREAU, *Walden o la Vida en los Bosques*, México, Novaro, 1959, p. 257. Por muchos años Thoreau ha sido marginado del círculo de escritores de habla inglesa de gran trascendencia; sin embargo, en palabras del *Concise Dictionary of English Literature*, Oxford U. Press, 1970, se dice que fue un "mystic,

Antes de comentar algunos puntos relativos a la situación en el noreste del país, quisiéramos referirnos a los efectos antropogénicos directos que pueden estar ejerciendo presiones negativas sobre las comunidades vegetales o animales. Es evidente que la expansión y dinámica de los asentamientos humanos está teniendo efectos espectaculares, por ejemplo en cuanto a una demanda acentuada de algunos recursos como es el agua potable; sin embargo, desconocemos la disponibilidad de estudios globales sobre los efectos derivados en recursos bióticos. Evidencia preliminar nos indica que por lo menos en algunas comunidades de la península de Baja California y el noroeste de Sonora el turismo documentado o subrepticio está afectando directamente a ciertos habitats.<sup>36, 37</sup> Sin embargo, en este contexto de efectos antropogénicos, el caso más preocupante por su focalización es el que se refiere a las intromisiones de turistas, observadores, periodistas e investigadores en los santuarios de ballenas adyacentes a Laguna Ojo de Liebre en la península de Baja California. Se ha calculado que cada año hay cerca de un millón de personas en observación a todo lo largo del llamado "express de las ballenas", mamífero marino que año con año desciende en el invierno, del pacífico norte hacia los lugares cálidos del sur. En reciente artículo de una revista de la AAAS pudimos contar hasta diez direcciones de organizaciones diferentes que ofrecen a los observadores servicios de "whale watching" en las apartadas aguas de esa parte de México; procede transcribir parte de la nota, "...este invierno en las tibias aguas de las lagunas de Baja California rodeadas por desiertos, cargamentos de turistas ligeramente nerviosos y muy ansiosos, partirán de su barco nodriza en busca de un animal salvaje. Su presa ha llegado en ocasiones ha embestir y hacer añicos algunas lanchas. El objetivo de los turistas será entrometerse en las mismísimas aguas donde el animal se aparea y pare..."<sup>38</sup> Sorprende en verdad en el contexto de los recursos del mar, el que haya quejoso por los retrazos o negativas a la autorización indis-

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transcendentalist and natural philosopher to boot", que se rebeló contra el puritanismo de Nueva Inglaterra, los valores materialistas de las sociedades de su época, la injusta guerra contra México, la esclavitud y la depredación humana de los bosques. Ardiente y agudo observador de la naturaleza, vivió aislado por dos años, en una cabaña que él mismo construyó cerca de Concord, New Hampshire; refiérese en su obra repetidas veces a la migración de aves rumbo a México; ver también "Following the tracks of a different man, Thoreau", en *Natl. Geographic* 159: Nº 3 (1981), p. 349, y sobre todo, para comprender a este fascinante precursor de la ecología humanística, valga la expresión, ver *Works of Henry David Thoreau*, con 30 fotografías, Nueva York, Avenel Books, 1981.

<sup>36</sup> E. EZCURRA, Instituto de Ecología, comunicación personal.

<sup>37</sup> M. DE AGÜERO, Fideicomiso Instituido en Relación con Agricultura, México, comunicación personal.

<sup>38</sup> D. MEREDITH, "Whales' Tales", *Science*, 81, 2: Nº 102 (1981); ver también J. S. KILLINGSLEY, "Migrations of California Grey Whales Tracked by Oxygen-18 Variations in Their Epizoic Barnacles", *Science*, 207 (1980), 759;

criminada de las diversas investigaciones planeadas.<sup>39</sup> Y es que el mar ya no es mundo separado y misterioso que esconde sus recursos, los muestra claramente en forma de rentables especies pesqueras,<sup>40</sup> de nódulos polimetálicos valiosos<sup>41</sup> y áurea historia rescatable por millones.<sup>42</sup>

Otro caso interesante de efecto antropogénico es el que ha sido sugerido para explicar el descenso en el número de las poblaciones de murciélagos nectaríferos que pasan parte del año en Texas y Arizona, E.U.A. y otra parte en Coahuila, México, donde está su alimento, el néctar de las inflorescencias del maguey. Hasta hace poco se habían identificado grandes poblaciones de ese tipo de murciélagos, llegándose a comunicar hasta 20,000 individuos en una sola caverna y en la actualidad la población total sólo alcanza unos cuantos miles. El descenso se atribuye al uso del maguey, para hacer bebidas, en la parte mexicana y la consecuente eliminación de la inflorescencia.<sup>43</sup>

Al hablar de murciélagos transfronterizos es relevante recordar los casos de especies hematófagas que transmiten enfermedades económicamente importantes del ganado, como el derrisgue o rabia bovina y la encefalitis equina de Venezuela que hace pocos años produjo una costosísima epizootia transponiendo fronteras;<sup>44</sup> en ocasiones la infección se puede extender a los humanos.

Con relación a la fauna del norte del país son muchas de las 350 especies de mamíferos las que están en franco peligro de extinción o extinguidas ya, como se dijo al presentar un breve inventario. Sin embargo en este problema se presentan variaciones según la provincia biótica y la localidad. En Nuevo León por ejemplo, se han identificado 122 especies de mamíferos de las cuales 39 son de interés cinegético, lo que incluye 4 especies en peligro de desaparición, 2 en proceso y 4 extinguidas totalmente que son venado bura, berrendo, ocelote, lobo y bisonte.<sup>45</sup>

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Varios, *La ballena gris*, México, Centro de Estudios Económicos y Sociales del Tercer Mundo, mayo, 1981.

<sup>39</sup> W. S. WOOSTER, "Ocean Research Under Foreign Jurisdiction", *Science*, 212 (1981), 754.

<sup>40</sup> J. J. MORALES, "La Lucha por el Atún", *Técnica Pesquera*, Año XIII, 24 (1980); ver también nota 32, pp. 127-128.

<sup>41</sup> V. E. McKELVEY, "Seabed Minerals and the Law of the Sea", *Science*, 209 (1980), 464; ver también H. DRECHSLER, "Los Nódulos Oceánicos", *Minería*, Vol. III: N° 17 (1980), 19. Órgano de la Cámara de la Industria Minera, México.

<sup>42</sup> N. WADE, "Galleon Yields Gold, Silver and Archaeology", *Science*, 212 (1981), 1486.

<sup>43</sup> J. GORMAN, "Beauty and the Bats", *Discover*, 2: 9 (1981), 30.

<sup>44</sup> R. GILLETTE, "V. E. E. Vaccine: Fortuitous Spin-off from B. W. Research", *Science*, 173 (1971), 405; ver también Instituto Nacional de Investigaciones Pecuarias, *Informe 1969*, México, 1969 y D. BATALLA, *Encefalitis Equina Venezolana*, Epizootiología, prevención y control. Notas mimeográficas.

<sup>45</sup> M. A. JIMÉNEZ GUZMÁN, "Especies en Peligro y Proceso de Desaparición

El problema de la extinción de las especies desde luego no es nuevo y aunque presenta una fuerte relación con las actividades cinegéticas, por lo menos en el norte del país, es parte de la ciencia integradora y dinámica como es la ecología, que presenta también un significativo componente cultural e histórico.<sup>46, 47, 48 \*</sup>

Aunque la ecología de la fauna fronteriza aún espera un estudio integral, hay ya instituciones interesadas en el problema y diversos proyectos en desarrollo, algunos de índole cooperativa entre instituciones de ambos países.<sup>49</sup>

Por la ubicación de la provincia biótica tamaulipecana y el contexto general de la geografía de México en el hemisferio, el caso de las aves migratorias ofrece características de gran singularidad y con muy diversas implicaciones.

Tan solo en la región de Laguna Verde, Veracruz, las aves migratorias identificadas pertenecen a 137 especies, riqueza determinada por la localización de la región en la vía migratoria de las zonas de anida-

en Nuevo León”, *Boletín, Centro de Investigaciones Biológicas de la Universidad A. de Nuevo León*, Año III, Nº 11 (1981), 5.

<sup>46</sup> T. C. MC LUHAN, *Touch the Earth, a Self-Portrait of Indian Existence*, London, Abacus, 1980. Este bello libro es una compilación de antiguos relatos de informantes indígenas que no alcanzaron a entender cómo el hombre blanco se sustraía, enseñoreaba y explotaba a la naturaleza, como alguien distinto a ella: por ejemplo, el Jefe Tatanga-Mani (Búfalo Caminante) señalaba en 1871, “¿Sabían Uds. que los árboles hablan? Pues bien, si lo hacen, hablan entre ellos y a Uds. les hablarán si les prestan atención. El problema consiste en que el hombre blanco no escucha. Nunca ha aprendido a escuchar al Indio, así que supongo que tampoco escucharán a las otras voces de la naturaleza. Yo he aprendido mucho de los árboles, en ocasiones acerca del clima, a veces acerca de los animales, otras acerca del Gran Espíritu.”

<sup>47</sup> F. TORRES AMAT, *Sagrada Biblia*, Librería Mexicanos Unidos, 1958. Génesis I.26 (Dios) “por fin dijo: hagamos al hombre a imagen y semejanza nuestra y domine a los peces del mar y a las aves del cielo y a las bestias y a toda la tierra y a todo reptil que se mueve sobre la tierra”; ver también Génesis I.28 y 29.

<sup>48</sup> Aun la cultura romana pagana guardaba un solemne respeto a la naturaleza y al desmontar o irrumpir en florestas y bosques hacia una ofrenda expiatoria y oraba: “Cualesquiera dios o diosa a quien esté consagrado este bosque, sea propicio a mí, mi familia y mis hijos.” Ver nota 35.

\* Vale la pena recordar en este punto el extrañamiento del gran Jefe Seattlo al rechazar una negociación con el hombre blanco en 1854... “he visto miles de bisontes pudriendose en las praderas muertos a tiros por el hombre blanco desde un tren en marcha. Soy un salvaje y no comprendo cómo una máquina humeante pueda importar más que el búfalo al que nosotros matamos en forma limitada sólo para comer”.

<sup>49</sup> G. HALFFTER y R. BARBAULT, *Ecology of the Chihuahuan Desert (Vertebrate Communities)*, México, Instituto de Ecología, 1981.

ción en Canadá<sup>50</sup> y E.U.A.\* con sus territorios invernales en México, Centro América y más al sur. Este estrechamiento que se va produciendo entre la costa y la Sierra Madre Oriental hace que la migración por esta ruta sea una de las más espectaculares del mundo, y corresponde a la ruta que en los E.U.A. es conocida como la ruta central; las otras dos son la ruta del Pacífico y la de Mississippi. La migración tiene lugar desde agosto a noviembre con la migración inversa de marzo a mayo. Muchas aves vuelan interespecíficamente y otras segregadas, y para mencionar un caso citaremos que de las golondrinas migran aproximadamente 200,000 por día hasta completar 10 millones.

El interés económico que puede tener esta migración aérea y transfronteriza de aves se debe a la capacidad que conlleva para transportar infecciones y plagas de un lugar a otro. Las aves como se ha dicho<sup>51</sup> “son” un conjunto de parásitos y microorganismos que pueden ser alojados sin daño aparente al huésped, que de hecho es un portador, un vector sano. En el caso de la industria avícola parte de la tecnología de producción y engorda se enfoca a evitar y controlar infecciones transmitidas por aves y que representan pérdidas anuales por muchos millones. En algunas ocasiones dichas plagas o enfermedades han sido transportadas hacia E.U.A. y en otras hacia México. Se ha estimado que a lo largo de los años se han introducido a los E.U.A., de diversas partes del mundo, 1,115 especies de insectos y ácaros de los cuales 20% constituyen real o potencialmente plagas agrícolas habiéndose calculado que, en promedio, se filtran de contrabando a los E.U.A. 8 plagas de insectos, causantes de pérdidas por valores de 1 a 4,000 millones de dólares por año. A la luz del problema, es evidente que el mismo es suficientemente importante como para ser estudiado con detenimiento por ambos países.<sup>52</sup>

En ocasiones los problemas derivados de la transmigración de aves son de índole no-infecciosa, como es el caso de absorción de pesticidas en altas dosis, por ejemplo en patos, mismos que se desplazan a otras regiones donde los cazadores deben ser alertados para tomar determinadas precauciones antes de su consumo ya que la grasa del pato

<sup>50</sup> *Canada and the Human Environment*, Ottawa, Minister of the Environment for Canada, 1972. En este documento se señalaba que “la extinción de especies que alguna vez sumaron millones dio ímpetu a la Convención de Aves Migratorias de 1916 en la que reconoce el valor cultural y económico de ese recurso internacional”. Los santuarios para aves migratorias abarcan 30 millones de acres (ca. 74 millones de hectáreas) que protejen, entre otras especies, a 100 millones de gansos que pasan el verano en Canadá.

\* Ver notas 34 y 35.

<sup>51</sup> J. K. TORRES, “Diseases of Birds: How and Why Some Birds Die”, *American Birds*, 35: N° 255 (1981).

<sup>52</sup> R. GIBBS y E. ERDE, “Biological Control of the Medfly”, *R. and D. Mexico*, 1:11 (1981), 16; e información proporcionada por el Instituto de Ecología, México.

concentra al pesticida.<sup>53</sup> También durante la década de los cincuenta y sesenta, en que la explosión experimental de armas nucleares por diversos países del hemisferio norte alcanzó niveles significativos, se llegó a la identificación de algunos casos de patos invernantes en la región de los Tuxtlas, Veracruz, posiblemente contaminados por partículas radiactivas.

Este último punto me acerca a otro aspecto que considero importante para dar final a nuestros análisis sobre los recursos naturales bióticos transfronterizos en un marco ecológico. Me refiero a todo aquello que implica el uso pacífico o no-pacífico de las tecnologías nucleares.

México recién está llegando al terreno de la tecnología nuclear y podemos aprender de los problemas de otros países que llegaron antes a este campo de los energéticos; como se ha señalado acertadamente, las naciones emergentes no deben repetir los errores de las naciones industrialmente más desarrolladas.<sup>54</sup> El campo de la energía nuclear requiere como muchos otros o quizás con mayor profundidad, de estudios sólidos de base ecológica, antes y durante la operación de actividades nucleares con aplicación en la paz. Dicha tecnología, como tantas otras, no es a prueba de error, aunque sus consecuencias son en sí de índole más seria. Al biólogo esencialmente le preocupan los aspectos de control para el uso seguro de las técnicas nucleares. Me pregunto si las instituciones y organismos responsables de proyectos de uso pacífico de la energía nuclear en México, digamos, como el Proyecto de Laguna Verde, Ver., han estudiado, desarrollado y utilizado las condiciones ecológicas integrales e idóneas, dada la singularidad del caso. Evidencia preliminar nos sugiere una respuesta afirmativa.<sup>55</sup> En este orden de cosas la frontera norte de México es vecina de una parte de E.U.A., donde hay numerosas instalaciones, centros de prueba y lugares experimentales para el uso y desarrollo de la energía nuclear, pacífica y bélica.<sup>56</sup> Considero que es indispensable estudiar permanentemente los posibles efectos de la contaminación, si es el caso, en ríos, cuerpos de agua, mantos freáticos y corrientes marinas a lo largo de las zonas de desechos en tierra firme y en las plataformas continentales.<sup>57, 58</sup>

<sup>53</sup> *Outdoor News Bulletin* (Wildlife Management Institute), 35: N° 20 (Oct. 1981), 1.

<sup>54</sup> H. BRAVO, "The Ecology of the Border", en Stanley R. Ross, ed., *Views Across the Border*, Albuquerque, University of New Mexico Press, 1978, páginas 412-413.

<sup>55</sup> Proyecto Laguna Verde del Instituto de Ecología; también, Informes a la Comisión Nacional de Seguridad Radiológica y Salvaguardia.

<sup>56</sup> *Nuclear Proliferation Factbook*, Joint Committee, Washington, United States Government Printing Office. "Nuclear weapons, accidents and incidents", p. 355; "Safeguards", p. 385.

<sup>57</sup> M. SUN, "White Sands, Warm Winds and Toxic Wastes?", *Science*, 211 (1981), 367; ver también "Nevada Closes Low Level Radioactive Waste Dump",

Para el suscrito, la frontera norte de México no sólo tiene un interés académico-científico, representa parte de la vida misma de sus antepasados, poseedores de tierras al noreste de Austin otrora San Felipe de Austin, del Estado Libre e Independiente de Coahuila y Texas<sup>59</sup> y sede precisamente de esta reunión; también por haber vivido el mismo autor durante varios años en Nuevo Laredo, Tamps., en la década de los cuarenta. En esos años una guerra total en el mundo hacía sentir una diversidad de efectos directos e indirectos en ambos lados de la frontera norte de México, y aunque corra el riesgo de ser tildado de exageración por mis compatriotas, me permito señalar que si hay alguna parte del país expuesta a las percepciones, efectos, angustia y peligros directos derivados de una conflagración mundial o sus previsiones, es precisamente la frontera del Norte de México. En la coyuntura actual de tensiones internacionales de alguna manera vienen a la memoria mis percepciones fronterizas al respecto, reforzadas en los años siguientes precisamente por la frecuencia de experiencias nucleares en el hemisferio norte y en las cercanías de la frontera norte de México.<sup>60, 61</sup> Yendo aún más lejos y sabiendo que en caso de una guerra total poco quedará del género humano,<sup>62</sup> no dejan de impresionarme las previsiones que se hacen acerca de la seguridad y peligros de la zona transfronteriza.<sup>63, 64</sup>

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*Science*, 206 (1981), 668; "Radioactive Waste Disposal in Thick Unsaturated Zones", *Science*, 212 (1981), 1457; "Manifest Destiny for Hazardous Wastes", *Science News*, 118: Nº 22 (1980), 345.

<sup>58</sup> L. MARDEN, "Man's New Frontier, The Continental Shelf", *Natl. Geographic*, 153: Nº 4 (1978), 495.

<sup>59</sup> Indica el Título de Posesión, Macogodoches, 21 de enero de 1834. Vicente Aldrete, Comisionado por el Supremo Gobierno del Estado de Coahuila y Texas para dar posesión a varios mexicanos de los terrenos que por venta les hayan sido concedidos por el mismo Supremo Gobierno en este Departamento de Texas... En nombre del Estado otorgo, concedo y pongo en posesión efectiva y personal de once leguas de terreno a las márgenes derecha e izquierda del Río Trinidad, los lindes de los cuales constan en los mapas y notas hechas por el agrimensor. De esta concesión, tres leguas pertenecen a tierras de temporal y las otras ocho leguas restantes a la clase de agostadero conforme a lo cual debe pagar al Estado la suma de mil doscientos pesos, de conformidad con el artículo 24 de la Ley de Colonización del 24 de marzo de 1825...

<sup>60</sup> G. M. WOODWELL, "Toxic Substances and Ecological Cycles", *Scientific American*, 216: Nº 3 (1967), 24.

<sup>61</sup> *Nuclear Proliferation Factbook*, Joint Committee, Washington, United States Government Printing Office, "Nuclear Explosions, 1944-1979", p. 375.

<sup>62</sup> A. HERRERA, *La Larga Jornada: la Crisis Nuclear y el Destino Biológico del Hombre*, México, Siglo XXI, 1981.

<sup>63</sup> G. W. RATHJENS, "Dynamics of the Arms Race", *Scientific American*, 220: Nº 4, 1969.

<sup>64</sup> *The Effects of Nuclear War*, Washington, D. C., Office of Technology Assessment, Congress of the United States, 1979.

## EPÍLOGO

REFLEXIONES PARA UNA TEORÍA ECOLÓGICA  
TRANSFRONTERIZA

Inicialmente señalamos que la totalidad de la vida guarda una relación holística y dinámica con la tierra en el seno de la biosfera. En este punto es correcto el cliché de la “nave tierra”. Vamos todos los seres vivos en el mismo barco. Ese vasto conjunto de interrelaciones entre naturaleza y organismos se manifiesta bajo una concatenación más o menos larga entre los diferentes espacios o territorios biogeográficos del planeta que permiten la aparición, abundancia, escasez o desaparición de determinados grupos de organismos a lo largo del tiempo. Diversidad de habitats implica diversidad de organismos, a lo largo de la historia de la naturaleza, esto es, la evolución. Zambullirse en ecología significa nadar en evolución.

La emergencia del hombre en la tierra y su horizonte histórico tienen una dimensión mucho más reducida que la de la historia natural \*; sin embargo, la capacidad humana para transformar el medio ambiente le dio desde el principio medios para llegar a utilizar los recursos naturales a su alrededor. El hombre lenta pero seguramente, ha actuado sobre su habitat hasta producir cambios que ya afectan al clima terrestre de manera importante.<sup>65</sup>

Nosotros pensamos, sin embargo, que las modalidades con que el hombre recurre a la naturaleza presentan una fuerte diferencia cultural, diferencia que hace a ciertas culturas más depredadoras de la naturaleza que otras. Si tomamos como ejemplo la historia de la desforestación, es evidente que la cultura europea característicamente arrasó con la casi totalidad de los bosques en ese continente a tal grado que Inglaterra, en un momento dado, agotó la madera y tuvo que cambiar al carbón mineral como fuente de energía. Pese a los esfuerzos de conservación de la vegetación que se hacían en la España clásica, en lo general su actitud era acorde con la actitud europea.

Evidentemente, la actitud española frente a la naturaleza pasó a las nuevas tierras descubiertas y el desmonte se dio a veces con pretextos sorprendentes.<sup>66</sup> El choque cultural entre los conquistadores del Nuevo

\* Ver nota 20.

<sup>65</sup> C. SAGAN, O. B. ROON y J. B. POLLACK, "Anthropogenic Albedo Changes and the Earth's Climate", *Science*, 206: (1979) 1363.

<sup>66</sup> F. CALDERÓN DE LA BARCA, *Life in Mexico*, N. Y., Anchor Books, 1970; señala la autora, visitante de México en 1840, el afecto indígena por la vegetación frente a la herencia española: "...los españoles como todo nuevo colono, echaron abajo los preciosos árboles de este hermoso valle... Me inclino a pensar que el

Mundo y sus antiguos habitantes no encontró mejor foro que el de las actitudes opuestas frente al aprovechamiento de los recursos bióticos,\* sea vegetación o fauna como se apuntó anteriormente.

Es por ello que un análisis estrictamente biológico del problema estaría incompleto. Al referirnos a la evolución biológica mediante la selección artificial debemos incorporar la evolución cultural, y al referirnos a las culturas eurocéntricas es notorio que la herencia judeo-cristiana a través del “poseerás la tierra” ha dejado una honda huella... y una secuela de problemas ecológicos. Tanto para la ética protestante como para los valores del catolicismo, la naturaleza “está ahí abajo” para ser poseída y domeñada.\*\*

En el plano económico y al nivel de los países centrales también ha sucedido que la explotación derrochadora y acelerada en beneficio del capital, la industria y el bienestar material, se ha visto acoplada a una peligrosa interferencia con la naturaleza, de manera que si hasta principios del siglo xx el derroche y la destrucción tenían un carácter limitado localmente, en la actualidad el aumento, capacidad y eficiencia tecnológica amenaza seriamente a las reservas del planeta que acumuladas por miles de años mantienen un equilibrio vital. El exportar las tecnologías obsoletas, contaminantes y ecológicamente agresivas a los países periféricos, sólo manifiesta una ideología malévolas en lo político e ignorante en lo ecológico.<sup>67</sup>

Para el biólogo el problema teórico se sigue complicando, pues es claro que las comunidades bióticas concatenadas en forma natural con el medio ambiente, son independientes de conceptos abstractos como los de frontera política o de teoría del estado. Bajo una óptica biológica las únicas barreras que distinguen los seres vivos son las barreras evolutivas. Sin embargo el estudio de esta nueva rama de la ecología, ¿ecopolítica?, sobre los problemas de los recursos naturales y el medio ambiente transfronterizo, implica ineludiblemente para el hombre la

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panorama es menos hermoso que en tiempos de Cortés; se ha cortado demasiada madera pues se tiene la absurda idea de que los árboles son malsanos; en una gran hacienda fui informada que se derribaron los árboles para impedir que los indios se reclinaran a reposar bajo su sombra.”

\* Ver nota 46.

\*\* La mentalidad de otras religiones difiere algo, p. ej.: Los antiguos hindús oraban al abrir la tierra:

“Oh, Diosa tierra, oh espacios anchos y perdurables  
Yo te saludo,  
Ahora comenzaré el cultivo  
Sé complacida o virtuosa.”

en C. B., HEISER, *Seed to Civilization, The Story of Man's Food*, San Francisco Freeman, 1973.

<sup>67</sup> S. R. OLIVER, *Ecología y Subdesarrollo en América Latina*, México, Siglo XXI, 1981.

consideración de lo abstracto. La naturaleza no distingue las barreras políticas pero el biólogo sí. Es más, dicho concepto, de carácter abstracto, el de "Frontera", es un concepto surgido en la mente del hombre y que, cuando es necesario, conveniente o posible lo lleva a marcar artificialmente la superficie misma de la tierra o sus representaciones. Evidentemente la marca conlleva un acto de soberanía, dominio o posesión sobre los recursos de ese territorio por un determinado grupo humano.

Aparece aquí un nuevo tipo de problema. Es un problema de tipo semántico, que en el caso que nos ocupa es de importancia también histórica y se refiere a la concepción de lo que significa frontera. Frontera estatal o línea fronteriza entre estados, es un término internacional cuyo trazado se establece formalmente por delimitación y eventualmente por desmarcación en la tierra y en sus entrañas, en las aguas y en sus honduras y fondo, en el aire; objeto de convenciones bi y multilaterales.<sup>68</sup> Sin embargo en el plano de la semántica, la cultura aglosajona da al término frontera otras connotaciones, relevantes precisamente a la "disponibilidad" de territorios no desarrollados, es decir con recursos aún no tocados por el hombre.<sup>69</sup>

¿Qué hacer entonces ante la contradicción que implica la posesión, usufructo, conservación o depredación soberana y unilateral por parte de un estado de derecho, de una naturaleza planetaria e interrelacionada, que además no conoce de barreras políticas?

¿Es acertado señalar que ese usufructo de recursos naturales está social y culturalmente predeterminado?

¿Cómo valorar aquellos casos en que el conocimiento, uso y conservación de los recursos naturales conlleva asimetrías de diversas clases entre países vecinos o cercanos, por ejemplo en cuanto a políticas de protección ecológica o planes?

¿Se inscribe este tipo de problemas de ecología transfronteriza en el marco de la polaridad sur-norte?, ¿este-oeste? ¿Se inscribe en el marco de la dialéctica de la dependencia?, ¿de las ideas neocolonialistas?, ¿racistas?

¿Cómo hacer frente al problema que representa la dinámica de los recursos naturales, por ejemplo el caso de las especies animales que transponen fronteras?, ¿o el de la atmósfera o algunos ríos y cuerpos de agua que pueden transportar substancias tóxicas o nocivas para los ecosistemas de países vecinos o cercanos?

<sup>68</sup> J. OSMAŃCZYK, *Enciclopedia Mundial de Relaciones Internacionales y Naciones Unidas*, México, Fondo de Cultura Económica, 1976.

<sup>69</sup> W. PAUL-ADAMS, *Los Estados Unidos de América*, 4<sup>a</sup> ed., México, Siglo XXI, 1980, p. 128. "Para los americanos, frontier no significa únicamente la línea de desplazamiento extremo de los asentamientos blancos." Según el Webster's 3rd. *New International Dictionary*, 1969, frontera tiene varias acepciones, una es "a zone or region that forms the margin of settled or developed territory".

¿Cómo responder a los retos futuros al Derecho Internacional, en cuanto al manejo, uso y conservación de los recursos del mar, en superficie, honduras y fondo?<sup>70</sup>

Responder a estas y otras interrogantes implica en primer lugar y por lo pronto, comunicación. Implica el encuentro de los discursos y la concertación mutua entre países. El diálogo se anticipa altamente complejo. Hemos podido identificar en una primera aproximación, no menos de medio centenar de instancias bilaterales de pertinencia sean Gobiernos Estatales, Comisiones, Convenios, Acuerdos, Organismos Federales, Instituciones de Enseñanza Superior, de Investigación y Desarrollo, Programas e Instituciones diversas que entre México y E.U.A. participan de alguna manera en los diferentes aspectos del problema de los recursos naturales bióticos transfronterizos. Sin embargo y no obstante lo complejo no hay otro camino, la base es el diálogo, para llegar eventualmente a la cooperación mediante la investigación científica y la educación en condiciones bilaterales.

Intencionalmente hemos dejado de lado algunas de las alternativas tradicionalmente sugeridas para enfocar posibles soluciones a los problemas ecológicos transfronterizos. Consideramos que por encima de un posible recetario, más o menos terapéutico, está el problema de la mentalidad humana hacia la naturaleza. Si las fronteras políticas son un invento de la mente del hombre, es en la mente del hombre donde se debe internalizar o recuperar el respeto y austeridad hacia los recursos naturales integrados al respeto y reconocimiento a las aspiraciones de bienestar social y económico entre los países, sean vecinos o no.

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<sup>70</sup> J. NEARY, "Pickleweed, Palmer's Grass and Saltwort; Tomorrow's food with Today's Saltwater", *Science*, 81: 2 (1981), 38.

## ANEXO 1

	<i>FLORA</i>	<i>FAUNA</i>
Abeto	<i>Abies</i>	Ardilla
Álamo	<i>Alnus</i>	Armadillo
Botoncillo	<i>Avicenia</i>	Berrendo
Bursera	<i>Bursera</i>	Borrego cimarrón
Candellilla	<i>Euphorbia antisiphilitica</i>	Cacomixtle
Cedro	<i>Libocedrus decurrens</i>	Castor
Ceiba	<i>Ceiba acuminata</i>	Chachalaca
Cholla	<i>Opuntia fulgida</i>	Oriental velute
Encino	<i>Quercus</i>	Codorniz
Enebro	<i>Juniperus</i>	Codorniz de Montaña
Garambullo	<i>Myrtillocactus geometryzans</i>	Cojolite
Gobernadora	<i>Larrea divaricata</i>	Cónedor de California
Guayule	<i>Parthenium argentatum</i>	Conejo
Hojasen	<i>Flourensia cernua</i>	Coyote
Huamúchil	<i>Pithecellobium</i>	Guajolote
Huizache	<i>Acacia</i>	Ganso
Jojoba	<i>Simmondsia chinensis</i>	Ganso de collar
Lechugilla	<i>Agave lechuguilla</i>	Gato montés
Liquidámbar	<i>Liquidambar</i>	Grulla
Madrío	<i>Arctostaphylos</i>	Hocofásán
Magüey	<i>Agave</i>	Huilota
		Jaguarundi

	<i>FLORA</i>	<i>FAUNA</i>
Mangle rojo	<i>Rhizophora mangle</i>	Jaguar Jabalí o Pecarí
Mezquite	<i>Prosopis</i>	Pecari, <i>Tayassu</i>
Nogales	<i>Juglans</i>	<i>Phrynosoma, Uta, Urosaurus</i>
Nopal	<i>Opuntia</i>	
Ocotillo	<i>Fouquieria</i>	<i>Lepus californicus</i>
Orégano	<i>Lippia graveolens</i>	<i>Canis lupus</i>
Palma	<i>Yucca, Sabal</i>	<i>Procyon lotor</i>
Palomulato	<i>Bursera simaruba</i>	<i>Lutra canadensis</i>
Pino	<i>Pinus</i>	<i>Felis pardalis</i>
Pino piñonero	<i>Pinus quadrifolia</i>	<i>Zenaidura asiatica</i>
Pino piñonero	<i>Pinus monophylla</i>	<i>Ursus</i>
Pino ponderosa	<i>Pinus ponderosa</i>	Aythya affinis
Pino ponderosa	<i>Pinus jeffreyi</i>	<i>Bucephala albeola</i>
Pino colorado	<i>Pinus coulteri</i>	<i>Melanitta perspicillata</i>
Sahuaro	<i>Carnegia gigantea</i>	<i>Felis concolor</i>
Sotol	<i>Dasylistron</i>	<i>Ondatra zibethicus</i>
Zacates	<i>Bouteloua, Muhlenbergia, Lycurus,</i> <i>Buchloe, Sporobolus</i>	<i>Crotalus</i>
		Rata almizclera.
		<i>Nasua narica</i>
		<i>Tigrillo</i>
		<i>Felis pardalis</i>
		<i>Didelphis marsupialis</i>
		<i>Taxidea taxus</i>
		<i>Gopherus</i>
		<i>Odocoileus virginianus</i>
		Venado cola blanca

*FAUNA*

Venado bura	<i>Odocoileus hemionus</i>
Venado temazate	<i>Mazama americana</i>
Zorra gris	<i>Urocyon cinereoargenteus</i>
Zorra norteña	<i>Vulpes macrotis</i>
Zorra del desierto	<i>Vulpes velox</i>
Zorrillos	<i>Mephitis, Conepatus, Spilogale</i>

*FAUNA MARINA*

Atún aleta amarilla	<i>Tamnus albacares</i>
Ballena gris	<i>Eschrichtius gibbosus</i>
Ballena jorobada	<i>Megaptera novaeangliae</i>
Ballena orca	<i>Eubalaena glacialis japonica</i>
Ballena cabeza arqueada	<i>Balaena mysticetus</i>
Barrilete	<i>Enhydnum pelamis</i>
Cachalote	<i>Physeter catodon</i>
Sábalos	<i>Megalops atlanticus</i>
Totoaba	<i>Cynoscion macdonaldi</i>

## COMMENTARY

JERRY R. LADMAN

The papers on natural resources aptly deal with two important and interrelated aspects of United States-Mexican border region's economic development. Dr. Servín describes the ecological concerns of the border region in the context of both border development as well as the meeting ground where ecological problems in the interior of the two nations come together and require bi-national solutions. Drs. Johnson and the two Hutchinsons analyze the very exciting and much publicized prospects for the commercial cultivation of traditional, arid-adapted crops, especially jojoba, as part of potential natural resource development in the border region. In my comments I would like to broaden the scope of their presentations from the perspective of a regional economist. By so doing I believe that we can better assess the role of natural resources in the development of the United States-Mexican border region and illustrate how this development may impact on the region's ecological balance. To begin it is useful to briefly review the role of natural resources in the historical development of the border region.

### NATURAL RESOURCES, ECOLOGY AND ECONOMIC GROWTH OF THE BORDER REGION

In the last half century the United States-Mexican border region experienced rapid population growth and economic development.<sup>1</sup> There are four fundamental and interdependent reasons.

First, although the region is basically arid, its rich natural resource base has lent itself to the production of goods for export. Especially important are agricultural products grown on the irrigated lands near the Colorado and Río Grande Rivers as well as mineral products, such as copper, mined in Arizona, Chihuahua and Sonora. The favorable

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<sup>1</sup> For purposes of this paper I consider the border region to be roughly comprised of those counties contiguous to both sides of the international boundary.

climate of the United States sunbelt contiguous with the border is another natural resource that has led to settlement and economic activity on the United States side. During the World Wars the reliable weather of the region was a factor in the United States government's decision to establish or expand military bases near the border. Most of the facilities remain and provide considerable employment and income at their sites. More recently some footloose United States industries have chosen to locate their production facilities or administrative headquarters in the border region, an important reason is the amenities offered by the sunbelt lifestyle.

Second, the existence of the border proper, has created a need on both sides for a host of governmental and private sector activities to deal with imports, exports, immigration and other transnational matters.

For both of these reasons the driving forces behind the development of the border were exogenous to the region. The demand for export products came from elsewhere in the two nations or the rest of the world. The need for military bases was the result of national defense and international relations. The footloose industries were providing products or services used elsewhere. Moreover, most of the transnational flows of goods and resources at border crossing points were in response to trade in products between the interiors of two countries.

Third, are the labor markets in the two countries. Real wages in the Mexican border region were higher than those in the interior of the country and attracted many persons. Moreover, real wages in the United States were higher than those of Mexico, inducing many Mexicans to come to the border in hopes of obtaining work in the United States. Note that these are also phenomena that are not specific to the border. Rather they derive from the external forces of labor market conditions elsewhere in the two countries, which caused a shift of the Mexican work force to the border region.

Fourth, government expenditure and policy, mostly those of the federal governments and not local authorities, has had an important impact on border development of both nations. On the United States side there has been considerable expenditure for infrastructure, land management and military installations. Likewise, Mexico has undertaken considerable expenditure, especially in the development of irrigation districts. It also undertook important policies to promote employment at the border; the most noteworthy are the Free Zone and the Border Industrialization Program.

The combination of these four factors, mostly emanating from factors external to the border, led to economic development and rapid population growth in the border region. As economic activity was initiated in response to the natural resource-based production, the activities of international border crossings and public policies demands were spawned for com-

mercial establishments to provide goods and services for the local populations. Local demand for some products was strong enough to create backward linkages to regional agriculture and manufacturing to provide products for local consumption. Later some of these industries became competitive in markets outside the border region and further contributed to its export base. Similar natural resources bases on both sides of the border as well as border transactions led to economic development on both sides, resulting in an interdependent bi-national border economy centered around twin border cities.<sup>2</sup>

As natural resource based-growth occurred it had an important impact on the ecological balance of the region. As examples, when the desert was turned under the plow and agricultural chemicals were introduced, when saline waters were used to irrigate or were dumped as waste into the Sea of Cortez, when mines were opened and mineral tailings were spread about the existing ecological balance was surely disrupted. Usually the changing balance was not confined to the nation of origin but rather spread to both sides of the border, a factor that led to international disputes.

The ecological balance was disrupted also by the side effects of the urban growth attendant with border economic development. Air and water pollution near these centers have impacted not only on the ecological balance but also on urban inhabitants. Although these effects may originate on one side of the border, they often spill over to the other.

#### **NATURAL RESOURCES AS THE BASIS FOR FUTURE DEVELOPMENT OF THE BORDER REGION**

Although the production of primary goods based upon natural resources has been an important factor in causing economic growth in many areas of the border region it should not be expected to be a major source of new stimuli in the future unless natural resources that are not presently used are brought into production. Rather the principal factors that will lead to increases in future growth are most likely to come from secondary production, such as manufacturing, and the provision of tertiary goods and services such as commerce and tourism. This view of future growth is based upon the fact that the readily accessible natural resources of the border region as we know them today, with the exception of climate, have already been tapped. As examples, the limited supplies of river and subterranean waters restrict expansion of

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<sup>2</sup> See my "The Economic Interdependence of Contiguous Border Cities: The Twin City Multiplier", *The Annals of Regional Science*. Vol. XIII: № 1 (March, 1979).

irrigated agriculture. Mining of the most accessible non-renewable resources has taken place, and production in the long-run will depend upon extracting of lower grade ores, barring new discoveries. Indeed, it is possible that the natural resource base of the border region may shrink; the availability of quality water may become more restricted and there are limits to the supply of the non-renewable mineral resources.

In contrast, the growing infrastructure, available work force and favorable climate of the border's urban centers provide a base for manufacturing of footloose type products, as exemplified by those of the Border Industrialization Program and electronics industries. As this type of activity expands and the border's population increases there will be increasing needs for commerce, services and industries to satisfy local demands. The well-established symbiotic relationship of contiguous bi-national border regions will assure that growth originating on either side of the border will to some degree spill over to the other, depending upon the strength of the bi-national linkages.

The intrinsic growth of the border region will have an impact on how the natural resource base is used. It is likely that some irrigated land formerly utilized to cultivate export crops may be converted to producing crops to satisfy local demands. Thermal energy sources in Baja California Norte will be increasingly developed as the bi-national demand for energy rises in that region.

It is important to recognize, however, that demand, external to the border region, is a precondition for the production of most natural resource-based goods near the border. In the future, as in the past, these products will be exported elsewhere in the world. Consequently, factors affecting external markets will play a predominant role in determining how the natural resources of the border region will be utilized. Given the above-mentioned limitations for irrigated agriculture, it is unlikely that irrigated land devoted to the production of the current crops can be expanded. It is possible, however, that the products grown on that land may be changed if world market conditions warrant.

The Johnson-Hutchinson paper explores the possibilities of opening new and unirrigated lands for arid-adapted crops, especially as sources of energy, oils and rubber. As they indicate, there is considerable current research by both nations to try to domesticate these native plants in order to adapt them to commercial production. However, as the authors state, production costs are high. Taken in a global context, this suggests barring significant breakthroughs to lower these costs and/or sharp rises in the prices of the alternate sources of similar or substitute products, that the large-scale commercial production of these products in the border region is not likely to come about in the foreseeable future because they will not be competitive on world markets. Again, it is clear that

factors external to the border will play an important role in determining what will be produced from the region's natural resource base.

**ECOLOGICAL ASPECTS OF FUTURE DEVELOPMENT  
OF THE BORDER REGION**

The previous two sections have briefly described how economic development in the border region impacts on the ecology of the area. They need not be repeated here. However, as Dr. Servín clearly demonstrates it is important to recognize in ecological matters that nature does not recognize an international boundary, and factors that influence ecological disturbances easily pass from one country to another. Such disturbances have been commonplace in the history of the border region. When they have occurred and have inflicted serious economic damage on one or both sides of the border formal mechanisms have been established to resolve the problem. A prominent example is the work of the bi-national Boundary and Waters Commission in their resolution of the salinity problem of the Colorado River.

It is important to recognize that the bi-national efforts have largely come into being to react to problems rather than to anticipate and prevent them. It is unlikely that this sequence will change in the future. Fortunately, successful prior collaboration bodes well for future cooperation. Moreover, for some types of problems, institutions, such as the Boundary and Waters Commission, are already in place and will facilitate their resolution.

As the border economy expands and rapid population growth continues more ecological problems can be expected to arise. However, the nature of future problems will be considerably different from those of the past, which have been mostly related to natural resources and livestock disease. In years ahead the larger problems will be due to the presence of large population centers and industry. The problems of water and air pollution and sewage disposal have already become important in twin border cities.

**CONCLUDING COMMENTS**

The two papers provide considerable information on their respective topics, but lack an overall border perspective. It has been my intent in these brief comments to try to place the papers in the broader context of economic analysis; specifically I have provided an overview of the role of the natural resources in the economic development of the border region and the likely impact of such development on ecology. In sum-

mary, in my view although natural resource-based production has been very important in the past it will become relatively less important in the future economic development of the border region; indeed it is likely to decline in an absolute sense. The driving forces of the future will be manufacturing, commerce and services. The future production of natural resource-based goods will depend upon their demand in markets external to the region, the production costs in the border and the availability of the resource base. Although major changes are not expected in the near future there may well be changes in the longer run. The possibilities of developing a commercially viable arid-adapted crop industry will depend on the external markets for these and substitute products as well as the success of research in lowering production costs. What is clear, however, is that as the economic activity and population of the border region grows, especially near the twin city complexes, there will be a host of new ecological problems emerging.

## COMENTARIO

VICENTE SÁNCHEZ

Para hacer mis comentarios, he partido de la base que la conferencia tiene por objeto: *a)* identificar los problemas y dilemas referentes a la frontera México-Estados Unidos, *b)* identificar y proponer líneas de investigación que sea necesario emprender, y *c)* sugerir estrategias, políticas y planes que puedan ser utilizados por aquellos a quienes corresponda tomar decisiones en torno al tema (incluyendo, por supuesto, a las poblaciones afectadas de ambos países). Si bien mis comentarios surgen de la lectura de los dos trabajos presentados sobre recursos naturales, hay algunos que trascienden el contenido de ellos y posiblemente las intenciones de sus autores al escribirlos.

Los dos trabajos presentados son de gran interés, pero muy diferentes en sus objetivos y planteamientos: el de Servín-Massieu es fundamentalmente una revisión general de la vegetación y fauna en la zona fronteriza (clasificada de acuerdo a criterios geográficos y ecológicos), una revisión también de algunos problemas ambientales, comunes a ambos lados de la frontera o que se trasladan de un lado a otro por mecanismos naturales o de responsabilidad humana, y una serie de interesantes reflexiones sobre el tipo de problemática ecológica y ambiental que se produce al existir una frontera administrativo-política, con todo lo que esto implica. El trabajo de Johnson y colaboradores tiene objetivos limitados; pero se refiere en forma creativa y estimulante a un problema de extraordinaria importancia: cómo aumentar la productividad agrícola en la región, identificando tierras no utilizadas o subutilizadas y/o la explotación de cultivos nuevos o tradicionales de zonas áridas. En resumen, el primero tiene más bien la intención de ofrecer un diagnóstico descriptivo general de los recursos naturales y de los problemas ambientales relacionados con ellos; el segundo, intenta ofrecer soluciones para problemas específicos identificados.

El tipo de problemas que estamos considerando (ambientales y de recursos naturales), es de aquellos en que confluyen para su producción factores, variables y parámetros de distintos orígenes. Consecuentemente, para estudiarlos y comprenderlos, se necesitan los conocimientos y los

datos que aportan muchas disciplinas (estudio multidisciplinario), los cuales es necesario luego integrar a través de ese difícil proceso que denominamos interdisciplinario. Es fundamental alcanzar algún grado de concepción interdisciplinaria si deseamos entender la gestión y dinámica de estos problemas, y estar en condiciones de hacer algo para influir su curso. En ese sentido, y considerando los objetivos de la conferencia, me parece desafortunado que hoy se traten los recursos naturales desde el punto de vista casi exclusivamente de las ciencias naturales, y mañana los problemas sociales que se relacionan íntimamente con el tema de hoy. En estas materias, si dividimos y subdividimos, lograremos encontrar datos precisos y exactos, pero no podremos entender y explicar satisfactoriamente la realidad que es global y mucho menos organizar una acción eficaz que logre las modificaciones que deseamos. Por lo demás, también se corre el riesgo de caer en reduccionismos y explicar estos problemas sólo desde el ángulo de las ciencias sociales, por ejemplo, ignorando las leyes naturales que son absolutamente fundamentales en este caso, o viceversa. Espero que la discusión entre todos los participantes colabore a solucionar el problema planteado asumiendo un carácter interdisciplinario.

Es de alguna importancia discutir y llegar a acuerdo sobre el significado de los términos que se utilizan al tratar los problemas ambientales. No se trata de una cuestión meramente formal, sino que por el contrario, se trata de los conceptos básicos que nos permitan entender claramente la gestación y características de estos problemas y comunicarnos sobre ellos en forma inequívoca para realizar acciones eficientes y eficaces.

Consideremos en primer lugar el término recursos naturales. Para los científicos naturales éstos son todos los bienes de la naturaleza, pero el significado que se ha impuesto, aun en el lenguaje diario, está más relacionado con el significado que el término tiene para la economía y la política, es decir, que los recursos deben reunir ciertas condiciones para serlo, básicamente ser utilizables en el ciclo económico y tener un valor de uso. Es así entonces, que consideramos recurso natural a un elemento de la naturaleza que, dependiendo de la tecnología, de los mercados, de la cultura y del conocimiento humano sobre él, pueda ser útil para satisfacer necesidades humanas, directa o indirectamente. Hablar de recursos naturales —como es característico de los problemas ambientales que nos preocupan— no significa sólo referirse a la naturaleza, sino que implica la organización y conducta del hombre en sociedad. Por ello hacer una enumeración de las especies que existen en una región determinada, no es suficiente. Necesitamos saber cuál es el papel de cada elemento natural en el mantenimiento del equilibrio del ecosistema, y cuál o cuáles son sus funciones de utilidad para el hombre en sociedad. El trabajo de Johnson y colaboradores se concentra justamente

en un aspecto relacionado con lo que menciono: el cómo convertir en "recursos" elementos naturales existentes, pero hasta ahora no claramente utilizables.

Otra cuestión terminológica que me parece fundamental aclarar es la que se refiere a lo que *es ecológico* versus lo que *es ambiental*. La ecología estudia los seres vivos, sus relaciones entre sí y con su entorno. Se refiere por lo tanto a la naturaleza. Por otra parte, medio ambiente incluye no sólo a las relaciones naturales, sino a las relaciones del hombre en sociedad con la naturaleza. Medio ambiente comprende a lo ecológico, pero este último no incluye a todo lo ambiental. Los problemas que estamos tratando, al hablar de la región fronteriza entre dos países, son, en el sentido expuesto, ambientales. Decir que son ecológicos no incluiría a una serie de facetas que, por lo demás, se mencionan en los trabajos, tales como las diferencias sociales y culturales y de nivel de desarrollo económico a ambos lados de la frontera; las diferencias tecnológicas, políticas y otras. Justamente las características ecológicas de la región no incluyen ni se ven en primera instancia afectadas por el hecho de que exista la frontera —un límite de tipo político-administrativo que surge de la organización social. Sin duda este límite determina diferentes realidades sociales a ambos lados, lo que significa formas distintas de relacionarse con la naturaleza y por lo tanto de manejar la realidad ecológica y el medio ambiente. Este hecho y los efectos que tiene sobre el ambiente puede ser un problema y es tema muy central de nuestras preocupaciones. Para resolverlo necesitamos estudios coordinados y acuerdos en la acción entre ambos lados de la frontera, lo que también es un problema social y político, pero no ecológico. En este sentido me parece poco afortunado hablar de ecología transfronteriza, y pienso que sería más útil referirnos a problemas ambientales transfronterizos.

También en el ámbito de las aclaraciones terminológico-conceptuales, creo importante establecer que cuando hablamos de efecto o impacto de las actividades humanas sobre los ecosistemas, no debemos sólo concentrarnos en los de carácter negativo, destructivo. Los hay positivos de gran importancia y es evidente que es necesario encontrar las mejores opciones. (*trade offs*) para llevar a cabo las actividades de desarrollo con el menor daño posible. La historia ecológica del mundo está llena de ejemplos que muestran cómo una especie se da mejor en un ambiente que no es el originario y en donde ha sido trasplantada; de casos en que ecosistemas enteros han cambiado su funcionamiento encontrando otro equilibrio funcional adecuado para sí y para el hombre que ha pasado a integrarlo; de casos también en que actividades humanas que normalmente significan interferencias importantes con el ambiente (industriales por ejemplo) son realizadas de diferentes modalidades y su impacto es notoriamente distinto. En suma, el problema no es interferir a la natura-

leza sino cómo se realiza dicha interferencia. Impacto no quiere decir solamente lo negativo, sino que hay muchos casos que son positivos. En este sentido es de primera importancia considerar que existen potencialidades inexploradas y no utilizadas de los ecosistemas, y que urge obtener la información científica (natural y social) necesaria para, por ejemplo, transformar en recursos elementos que no lo son en la actualidad (ej. el trabajo de Johnson y colaboradores).

Aclarados algunos de los conceptos básicos que nos pueden permitir entendernos mejor, desearía plantear lo que sería necesario hacer para aproximarnos a los problemas ambientales fronterizos y en último término resolverlos. Me parece conveniente organizar la acción en las siguientes etapas/procesos:

- Diagnóstico o evaluación ambiental.
- Planificación ambiental (o formulación de algunas políticas y estrategias).
- Manejo o gestión ambiental (coordinada y de común acuerdo).

Estas tres etapas/procesos deberían realizarse secuencialmente. Sin embargo, existe bastante conocimiento e información acumulados sobre el tema, los que sometidos a un mínimo ordenamiento y jerarquización pueden permitir proceder, aunque sólo sea parcialmente, a trabajar en todas las etapas/procesos desde muy pronto. No tendría sentido esperar tener todo el conocimiento y la información para actuar. Se correría el riesgo de quedarse estancados en la etapa de estudios e investigaciones sin llegar nunca a la acción necesaria: la gestión ambiental adecuada a la situación. En lo que sigue comento brevemente cada una de las etapas/procesos mencionados.

*Diagnóstico o evaluación ambiental.* Entiendo por ello un diagnóstico descriptivo y funcional, que no sólo nos ofrezca una enumeración de especies de flora y fauna existentes, sino el estado funcional de los ecosistemas, su resistencia, las potencialidades aún no expresadas, las posibles reacciones frente a diferentes tipos de interferencia humana y los problemas ambientales existentes en la actualidad. Se necesitan diversos estudios e investigaciones que tendrán forzosamente carácter multidisciplinario, pero que deben llegar a evaluaciones y juicios integrados (interdisciplinarios). Éstos pueden tener carácter provisorio en un primer tiempo, pero las aproximaciones sucesivas en la acción consistente en el manejo de los ecosistemas pueden ir fundamentando los mejores. Por lo demás, el diagnóstico debe, por fuerza, incluir elementos de la estructura social, el nivel de desarrollo, las posibilidades tecnológicas y otros factores similares, para que sea un diagnóstico global referido a la *realidad ambiental*, única manera de que nos preste un

servicio eficaz para orientar nuestras acciones. El diagnóstico del que hablamos puede tomar en la práctica varias formas distintas: ser un estudio integrado del "estado del medio ambiente en la región fronteriza", o puede consistir en estudios específicos referidos a una localidad y/o a una actividad humana determinada (industria, explotación agrícola, asentamientos humanos, etc.). La verdad es que no hay contradicción entre ambos procedimientos y más bien ambos son necesarios y complementarios.

*Planificación ambiental.* Se trata de establecer, sobre la base de los datos de diagnóstico existentes, grandes líneas de desarrollo, políticas y estrategias. En efecto, de acuerdo a las características conocidas, tanto naturales como sociales y culturales, sería necesario establecer qué estudios e investigaciones son prioritarios; cuáles proyectos y acciones de desarrollo serían más adecuados, logrando la mayor productividad posible con la menor destrucción ambiental; cuáles serían las mejores formas de asentar a la población, y cómo puede organizarse el empleo y en qué y cómo podrían éstas colaborar mutuamente en el estudio y manejo de la región.

*Gestión ambiental.* Consiste en la acción para conservar, proteger, regenerar y desarrollar al medio ambiente, e incluye a todas las acciones y maniobras que se realicen sobre el ambiente con fines de desarrollo económico y social. El conocimiento sobre las características del medio ambiente debiera ser un insumo importante en el proceso de toma de decisiones con respecto al desarrollo de la región fronteriza. Y esto debiera ser así en todos los niveles, en la formulación de planes y políticas de desarrollo y en cada uno de los proyectos específicos. El problema surge, como he dicho, en el caso de una región fronteriza, porque los ecosistemas naturales tienen continuidad a través de la frontera; sin embargo, las políticas y estrategias de gestión del medio ambiente pueden ser muy diferentes por razones económicas, culturales, sociales, políticas, bélicas, y otras. De ahí la importancia de acuerdos y convenios, y posiblemente de comisiones conjuntas para establecer los criterios de gestión ambiental y, aun más, realizar la gestión conjuntamente. Esto debe considerar algunos instrumentos coadyuvantes de la gestión ambiental tales como legislación ambiental, educación ambiental, formación y capacitación de profesionales y técnicos, actividades susceptibles de acuerdos y coordinación transfronteriza.

Algunos breves comentarios adicionales. Ninguno de los trabajos ha tocado el problema de los recursos marinos, que son de enorme importancia. Es posible que la experiencia reiterada de conflictos transfronterizos en relación con los recursos del mar, comenzando por la dificul-

tad en aceptar criterios comunes para fijar los límites fronterizos en el mar y los derechos que de ellos derivan para cada una de las partes, convierta a ése en un problema difícil de tratar. Está por lo demás la larguísima experiencia de la Conferencia del Mar, que lleva más de cinco años en las Naciones Unidas sin llegar a acuerdos. Desafortunadamente, Estados Unidos ha sido el país que más dificultades ha puesto para llegar a acuerdos que tengan algún sentido práctico y sean viables. Están también los problemas derivados del uso de la energía nuclear, mencionados por Servín-Massieu, que requerirían un análisis concienzudo y cuidadoso, también conjunto. El ejemplo del WIPP (tiradero de desechos nucleares en el estado de Nuevo México) es uno que a mi juicio sigue planteando problemas eventuales para México. Es evidente que debieran existir mecanismos de consulta entre ambos países para resolver satisfactoriamente tales dilemas. Sin embargo no parece que se pusieran en práctica. Por todo ello, la existencia de la tantas veces mencionada "voluntad política" por parte de los gobiernos, es uno de los elementos que hace falta en grandes dosis para realizar una gestión ambiental adecuada en forma conjunta. Las poblaciones locales, a ambos lados de la frontera y sus gobiernos, municipales y estatales, posiblemente podrían jugar un papel importante en la realización de estudios, en la formulación de políticas y en la realización concreta de la gestión ambiental. El interés de estas comunidades tiene que ser alto, puesto que sufren directamente los problemas. Por ello debieran cooperar más para resolverlos, más que los gobiernos centrales, que están más lejos y deben encarar problemas macro-políticos en sus relaciones.

Un último comentario que deseo hacer es sobre el papel que corresponde a los universitarios y científicos en la solución de los problemas ambientales transfronterizos. He mencionado las dificultades que surgen en el terreno político y cómo ahí estarían, en último término, las posibilidades de tomar decisiones que tengan un peso definitorio. Sin embargo, a los científicos y estudiosos universitarios nos queda un espacio muy importante que debemos llenar y que es adicional al que cada uno puede ocupar en su calidad de ciudadano y miembro de la comunidad que le corresponda. En efecto los académicos pueden y deben, a mi juicio:

- ofrecer claridad conceptual en torno al tema
- determinar prioridades de estudio y recolectar datos pertinentes
- interpretar los datos para aclarar la dinámica de la problemática y así permitir que se establezcan criterios reales de solución
- ofrecer sugerencias técnicas de políticas y estrategias viables y recomendables para resolver los problemas ambientales a ambos lados de la frontera.

Estos elementos podrían ser valiosos aportes para aquellos a quienes corresponda tomar las decisiones.

En suma, estoy haciendo un llamado para estudiar y enfocar estos problemas en forma integrada y transdisciplinaria —única forma eficaz a mi juicio— y con un alto nivel de descentralización que entregue responsabilidades crecientes a las poblaciones locales en la solución de sus problemas.



## SÍNTESIS DEL MODERADOR

JORGE BUSTAMANTE

La sesión inicial de esta reunión y la sección resultante del libro se dedica a los recursos naturales en la zona fronteriza de México y los Estados Unidos. Ciertamente, los temas de este simposio representan un paso muy importante en la concientización de problemas de naturaleza ecológica, misma que consideramos absolutamente indispensable. Por lo menos en México —podemos afirmarlo con autocrítica— hemos dado en el pasado muy poca importancia al estudio científico de estos problemas que relacionan el medio ambiente físico con el medio ambiente social.

La delegación mexicana quedó muy complacida por la actitud de la delegación de los Estados Unidos, al aceptar generosamente nuestra sugerencia para que dedicáramos este segundo simposio de la serie al tipo de problemas de carácter ecológico en la región fronteriza. Así, visualizamos escenarios sumamente dramáticos, relacionados con la falta de información, de entendimiento y de conciencia respecto del desarrollo inevitable de muchos de estos problemas que encapsulamos en el concepto de problemas ecológicos. No se trata, desafortunadamente, de aquellos que pudieran referirse a un régimen jurídico ya desarrollado o unitario, o bien a un mismo marco de soberanía, sino precisamente de una serie de problemas ecológicos que, aparte de las limitaciones para resolverlos, compartimos con otro país, nada menos los Estados Unidos. En estas condiciones, los problemas ecológicos de la región fronteriza adquieren aún más importancia.

Es preciso que antes de que estos problemas nos lleven a la realidad dramática de movilizaciones de gente y de gobiernos en relación con su desarrollo, quienes nos hemos dedicado al estudio de los mismos y hemos declarado nuestra pretensión de tener capacidad para estudiarlos y anticiparlos, no seamos condenados por nuestra propia historia, en el sentido de no haber llamado la atención sobre la realidad y sobre el futuro del desarrollo de estas cuestiones de ecología en la zona fronteriza. Está prácticamente todo por hacer. Hemos, desde luego, contado con pioneros sobre algunos de los problemas que vamos a tratar aquí.

Es triste que por el lado mexicano contamos casi con el 100% de nuestros expertos en el área en esta reunión, lo que da una indicación del bajo nivel que nuestras universidades conceden al financiamiento para la investigación en estas áreas. Pero el financiamiento, como todos sabemos, es un elemento de la investigación que tiene que ser preparado de manera no científica. Y es muy importante que una reunión como ésta pueda aportar los elementos de concientización que necesitamos los investigadores para obtener el apoyo, con objeto de hacer la investigación que se requiere y así entender de una manera científica los problemas a resolver.

Los dos ensayos sobre "recursos naturales" tratan aspectos selectivos de los recursos, actuales o potenciales, de desarrollo de la región. Los profesores Johnson y Hutchinson, con un enfoque muy positivo, identifican oportunidades posibles para nuevo desarrollo en agricultura. Después de definir la región fronteriza, los ensayistas especifican áreas dentro de esa región con posibilidades para tal desarrollo.

El enfoque, muy original y selectivo, se concentra en el uso de plantas silvestres como nuevos cultivos en tierra árida. Los autores dan énfasis a las posibilidades físicas y económicas, dejando los aspectos sociales para consideración posterior. El ensayo tiene dos anexos útiles. En el primero se identifican las instituciones mexicanas y las estadounidenses que se ocupan en la investigación de nuevos cultivos. En el segundo anexo se enlistan plantas prometedoras y los resultados de investigaciones recientes relativas a ellas.

En su ensayo el profesor Servín-Massieu también es selectivo, sugiriendo que la categoría de "recursos naturales" tiene tan numerosas facetas que justificarían una conferencia dedicada exclusivamente a este tema. Concede particular relevancia a los recursos naturales bióticos en el marco de la ecología transfronteriza. Sostiene que la ecología es una ciencia totalizadora e interdisciplinaria que busca el entendimiento de las relaciones entre los seres vivos, el hombre incluido, y el mundo que los rodea. Al considerar los problemas en forma aislada, aunque se haga de manera correcta, se corre el riesgo de perder la visión de conjunto.

Es difícil dar a la ecología una sola visión. Aunque los biólogos reclaman el derecho de paternidad, la visión integral puede lograrse desde muy distintas perspectivas. El profesor Servín-Massieu, en su análisis de los recursos naturales bióticos, ha procurado realizar su estudio de manera que pueda integrarse al resto de los trabajos que se presentan en esta publicación. El investigador presenta un inventario de la flora y la fauna de cinco zonas bióticas principales en la región fronteriza, definidas geológicamente y ecológicamente, y además detalla los sistemas más frecuentes.

El profesor Servín-Massieu, como todo investigador serio, rechaza utilizar "la retórica catastrofista usual que busca horrorizar con las

consecuencias de los pecados contra el equilibrio de la naturaleza para conmover al interesado". No es sorprendente la ineficacia de este tipo de mensaje, pues "en gran medida los problemas del medio ambiente tienen implicaciones profundas de índole política, social e históricamente predeterminadas". También rechaza las posiciones que suelen asumir tanto los conservadores en asuntos ecológicos como los consumidores del medio; los primeros, abogando por la supervivencia y la conservación del medio totalmente al margen de la producción y del hombre mismo y, los últimos, favoreciendo el aprovechamiento ecológico irreflexivo para beneficio exclusivo del capital. El ensayista prefiere una opinión integral y racional como la que ofrece el concepto de "reserva de la biosfera" promovida por la UNESCO.

El profesor Servín-Massieu es consciente de la profunda repercusión que ha tenido en la región el desarrollo económico (en los aspectos de la agricultura, la ganadería y la industria) y el de la población, lo cual ha contribuido "a una mayor degradación y perturbación de los ecosistemas naturales". Recomienda "el estudio interdisciplinario sistemático sobre los posibles efectos del deterioro ambiental localizado y sus alcances regionales y mundiales para las comunidades bióticas". En un anexo cita la flora y la fauna con ambos nombres, el científico y el común.

Los dos comentaristas, por su parte, tomando como base los ensayos presentados, amplían el alcance de la discusión y además plantean cuestiones importantes. Así, el profesor Vicente Sánchez enfatiza la necesidad de realizar estudios multi e interdisciplinarios para comprender la gestión y la dinámica de estos problemas, y estar en posición de influir su curso.

El profesor Sánchez continúa sus reflexiones al observar que ambos ensayos abordan el tema casi exclusivamente desde la perspectiva de las ciencias naturales, en tanto los aspectos sociales se tratan en otra sección. Es desafortunado que así sea pues los dos enfoques son necesarios. Además señala la ausencia de referencias a los recursos marinos, pero reconoce las dificultades para abordar el tema en todos sus aspectos. También formula algunas observaciones y preguntas que se consideran muy valiosas y a las cuales nos referimos enseguida.

En primer lugar, identifica la necesidad de definir lo que es recursos naturales y diferenciar entre lo ecológico y lo ambiental. Asimismo, conviene reflexionar sobre las relaciones del hombre asociado a la naturaleza. Observa también que al haber efectos y repercusiones tanto positivas como negativas, no debemos concentrarnos en estos últimos y especialmente en los destructivos. De ahí que deban buscarse las mejores opciones ("trade offs") para realizar las actividades de desarrollo causando el menor daño.

En segundo lugar, la sola existencia de la frontera política requiere estudio y acción coordinados. En tercer lugar, estima que se requiere es-

## **100 • Síntesis del Moderador**

tablecer un mecanismo consultivo para resolver el dilema de los desechos nucleares. Finalmente, exhorta a estudiar los problemas que nos vienen ocupando con un enfoque integral y transdisciplinario "...con alto nivel de descentralización que entregue responsabilidades crecientes a las poblaciones locales en la solución de sus problemas".

Nuestro segundo comentarista, el profesor Ladman, habla como un economista regional. Cree que así se puede evaluar mejor el papel de los recursos naturales en el desarrollo de la región fronteriza y demostrar cómo este desarrollo podría tener repercusión en el balance ecológico de la región. Hace notar que la fuerza impulsora para el desarrollo en la región fronteriza ha sido atribuido "a causas externas a la región: la demanda para productos de exportación, mercados de trabajo, gastos y política del gobierno. Este conjunto de factores, en gran parte ajeno a la frontera, condujo al desarrollo económico en la región".

El desarrollo basado en los recursos naturales ocurrió y tuvo un efecto importante en el balance ecológico de la región. Por otra parte, ese balance ecológico también fue desorganizado por efectos laterales del crecimiento urbano que acompañó al desarrollo económico fronterizo. El profesor Ladman concluye su comentario con una consideración breve sobre los recursos naturales y los aspectos ecológicos implicados en el desarrollo futuro de la región fronteriza. Vaticina que la producción basada en los recursos naturales jugará un papel menos importante si se le compara con la industria, el comercio y los servicios; estos últimos constituirán la fuerza impulsora del desarrollo.

Es muy interesante que cada participante haya recomendado esfuerzos binacionales, tanto multidisciplinarios como interdisciplinarios, para estimular nuestra conciencia y entendimiento de aquellos problemas que rebasan las fronteras internacionales. Y esto, por supuesto, es lo que hemos realizado en este simposio.

## ENGLISH SUMMARY

Environmental problems in the border region between Mexico and the United States are complicated by the fact that they are shared by two national jurisdictions. Against the neglect of the past, there is need to contribute to the awareness and understanding of such problems. That is the very process in which this symposium is engaged. The moderator lamented the shortage of skilled and dedicated manpower, particularly in Mexico, for the task of studying and anticipating these problems.

The two essays deal with selective aspects of present or potential natural resources in the border regions. The essays had to be selective because of the multifaceted nature not only of natural resources in the region, but also generally of the symposium theme of "Ecology and Development in the Border Region". Professors Johnson and Hutchinson concentrate on the use of wild plants as new crops in arid lands. Professor Servín-Massieu places his emphasis on the biotical communities within the context of transboundary ecology.

The moderator noted that the essayists and commentators, Professors Sánchez and Ladman, all called for binational multidisciplinary and interdisciplinary studies to increase our awareness and understanding of ecological problems which are not confined by the international boundary.



*AIR*

III

AIRE



# ASPECTOS METEOROLÓGICOS DE LA CONTAMINACIÓN DEL AIRE A LO LARGO DE LA FRONTERA NORTE DE MÉXICO

ERNESTO JÁUREGUI

## INTRODUCCIÓN

La frontera norte de México se extiende a lo largo de 2,597 km. de longitud, desde la planicie costera del Golfo de México en Tamaulipas, hasta la costa del Océano Pacífico en Baja California.

Fisiográficamente la faja fronteriza está constituida principalmente por los sistemas montañosos de las sierras madres que la cruzan de sur a norte en su porción central en un trecho de 1,200 km. entre Ciudad Acuña, Coah. y Sonoita, Son. Flanqueando las sierras se encuentran las llanuras de los valles del Río Bravo hacia el este y el Río Colorado hacia el oeste. Finalmente, separando el valle del Colorado de la costa del Pacífico, la zona fronteriza es cruzada de norte a sur por la Sierra de la Rumorosa.

Dos grandes ríos se encuentran en la faja fronteriza: el Bravo, que la recorre en más de la mitad de la línea internacional, hacia el SE de Ciudad Juárez y el Colorado que cruza la región al norte del Golfo de California en cuyas aguas desemboca.

En un trabajo anterior<sup>1</sup> se describieron los diversos factores generales del clima de la región fronteriza. En el presente trabajo se enfocará la atención a los aspectos meteorológicos de la contaminación del aire a lo largo de la faja fronteriza ya que, como se sabe, tanto el crecimiento acelerado de los núcleos urbanos fronterizos como las actividades agro-industriales implican el riesgo del deterioro potencial de la calidad del aire en esa región del país. Este riesgo es ya un hecho real en algunos puntos de la frontera, como se tratará de demostrar más adelante.

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<sup>1</sup> ERNESTO JÁUREGUI, "Recursos Naturales y Medio Ambiente en la Frontera Norte de América", en *Estudios Fronterizos*, México, ANUIES, 1981, pp. 51-68.

### EL FLUJO GENERAL DEL AIRE EN LA FRONTERA NORTE

El clima general de la región fronteriza se caracteriza principalmente por un déficit casi permanente de las precipitaciones cuyo origen es la influencia de los anticiclones semipermanentes tanto del Atlántico como del Pacífico Norte (Fig. 1). El flujo general del aire en la faja fronteriza es de oeste a este en el invierno y primavera (Fig. 2a) a unos 1,500 m. de altura. En esta época cruzan la región fronteriza masas de aire polar que abaten considerablemente la temperatura y acarrean nublados con algunas lluvias o nevadas. En el verano, la porción centro-oriente de la frontera se encuentra bajo la influencia de la corriente húmeda de los vientos del este (alisios) que traen consigo las escasas lluvias entre agosto-octubre (Fig. 2b). Sólo excepcionalmente afectan a la región lluvias extraordinarias asociadas a las tormentas o ciclones tropicales, en particular a la cuenca del Río Bravo. Resumiendo puede decirse que en el semestre centrado en el invierno las corrientes de aire dominantes cruzan la región fronteriza de norte a sur o de NW a SE, mientras que en el verano el flujo medio del aire, además de ser menos intenso que en el invierno y primavera, se lleva a cabo de SE a NW cruzando la mitad oriente de la frontera en dirección opuesta en esta época calurosa del año. En la mitad poniente de la faja fronteriza (al W de Ciudad Juárez) continúa dominando la circulación de norte a sur o de NW a SE característica de la estación fría.

Esto último se debe a la presencia de la celda de baja presión ubicada en el norte de Sonora y sur de Arizona (Fig. 1). Dicha celda se origina por el intenso caldeamiento en esa región árida. Localmente, la circulación general del aire anteriormente descrita se modifica por factores topográficos o por la influencia del mar en los extremos de la frontera, como se verá más adelante.

### LAS PROPIEDADES DE DIFUSIÓN DEL AIRE EN LA FRONTERA

#### *La estabilidad atmosférica*

Las propiedades de difusión de una capa de aire dependen de su capacidad para diluir y transportar los contaminantes sólidos (partículas o polvos) y gaseosos que se arrojen en su seno. Así, si la velocidad del viento es energética y además el aire se encuentra en gran agitación por las corrientes turbulentas verticales convectivas en un mediodía soleado, las impurezas se diluirán rápidamente. En este caso se dice que la atmósfera es *inestable*. Por otra parte, si el flujo del aire es débil y, además, en vez de calentarse desde abajo como ocurre durante el día, el

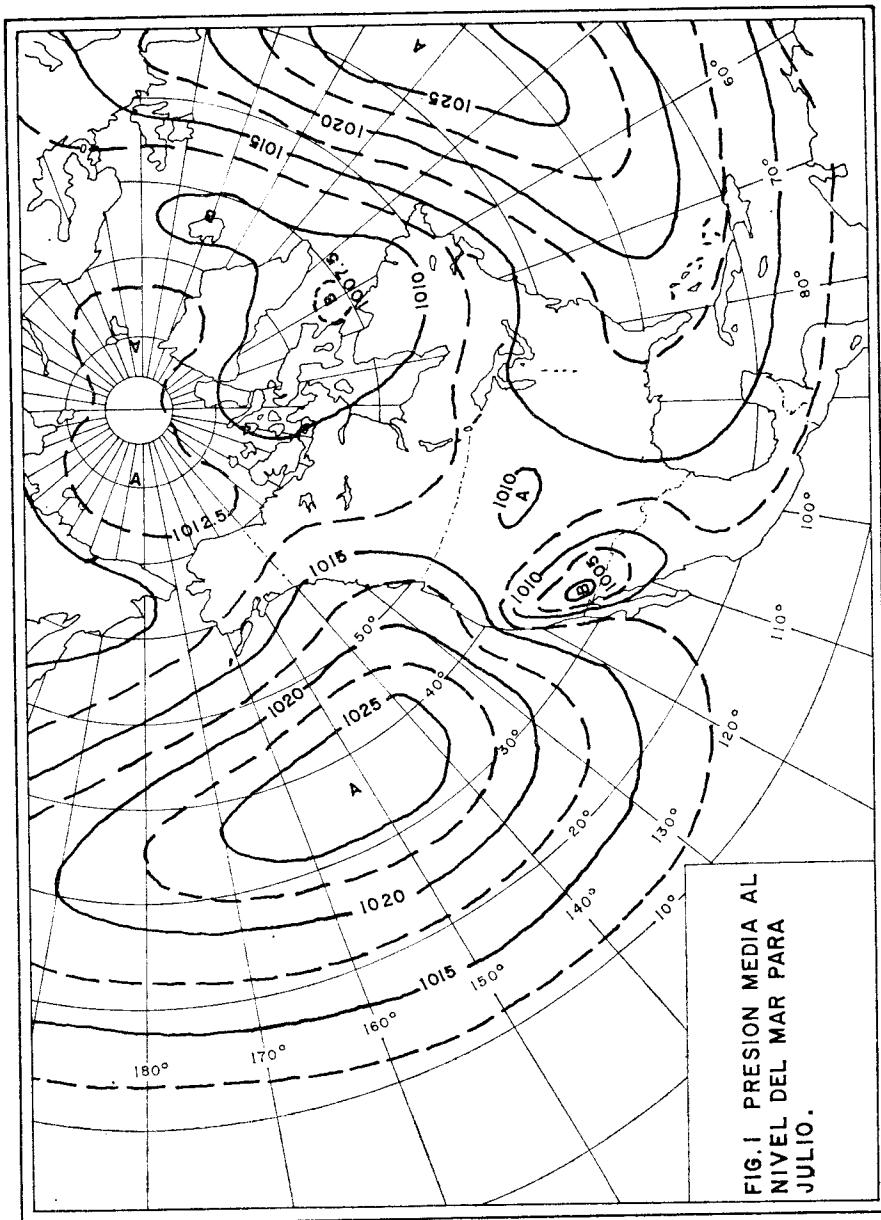
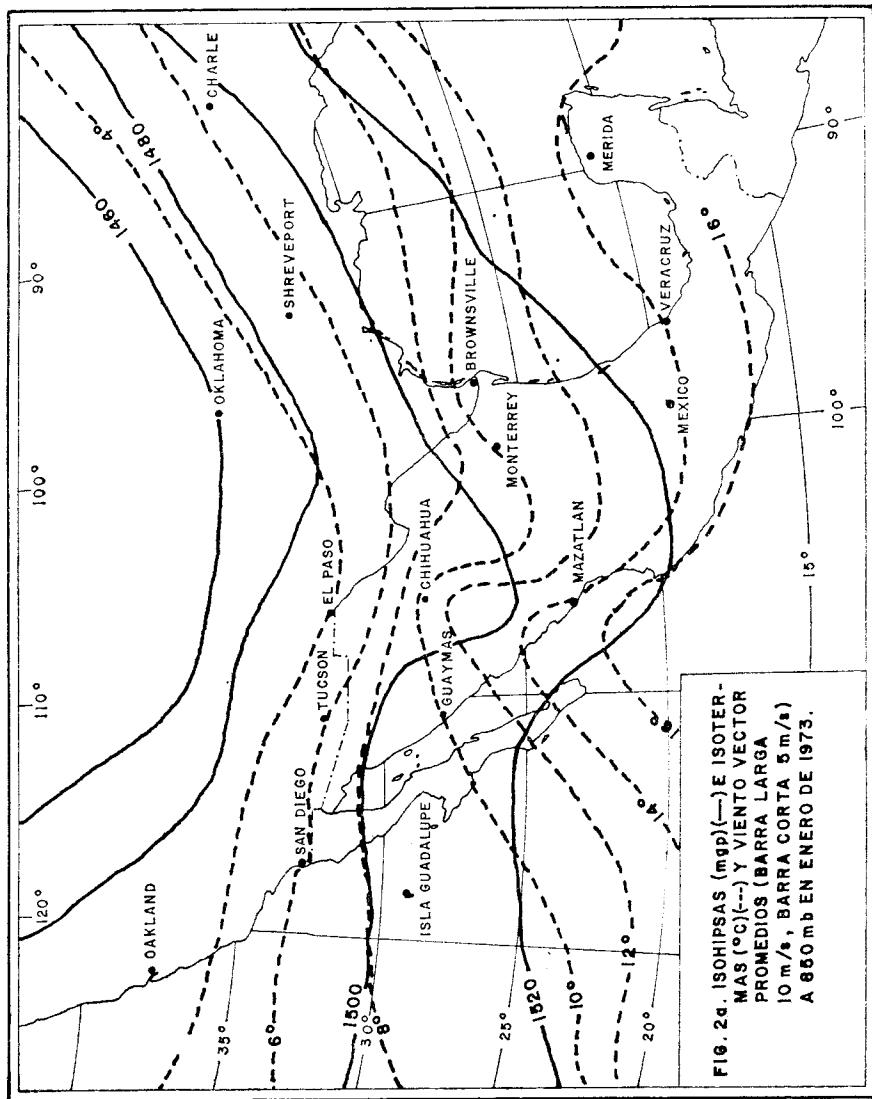


FIG. I PRESIÓN MEDIA AL  
NIVEL DEL MAR PARA  
JULIO.



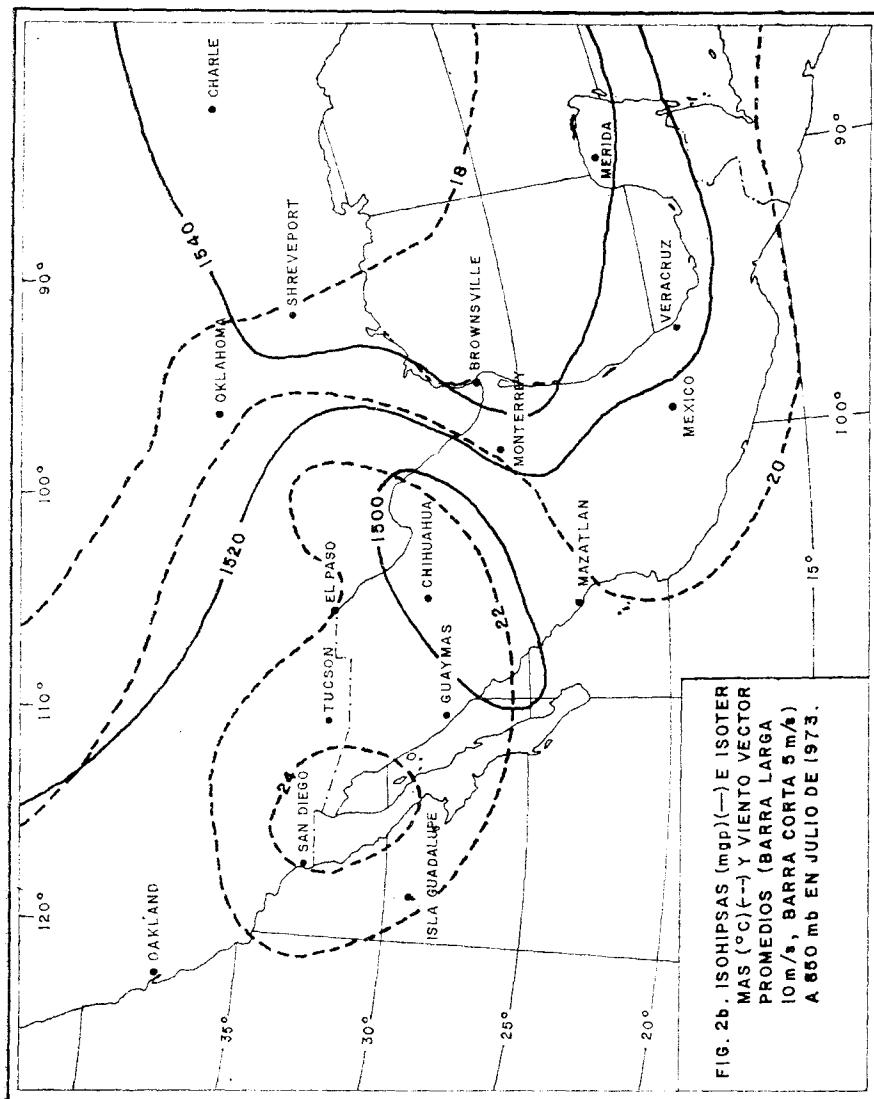


FIG. 2b. ISOHIPSAS (mpp) (—) E ISOTER  
MAS ( $^{\circ}$ C) (---) Y VIENTO VECTOR  
PROMEDIOS (BARRA LARGA  
10 m/s., BARRA CORTA 5 m/s.)  
A 850 mb EN JULIO DE 1973.

aire se enfriá por contacto con el suelo durante la noche (inversión térmica) entonces los contaminantes que se arrojen en este aire se mantendrán por largo tiempo sin diluirse ni transladarse.

En este caso se dice que la capa de aire es *estable* y sus propiedades de difusión son malas. Entre estos extremos de la capacidad de dilución que tiene la atmósfera se encuentra una diversidad de condiciones intermedias.

En general, la estabilidad de la capa superficial de aire (donde se arrojan los contaminantes) muestra casi siempre un ciclo diurno: el aire es *estable* durante la noche y al amanecer por el balance negativo de radiación, mientras que después del mediodía y al atardecer el aire es *inestable* debido al asoleamiento. En un lugar dado prevalecerá más tiempo una condición que la otra.

Una manera de valuar las propiedades de difusión del aire es midiendo la frecuencia en que se presentan las condiciones de aire *estable* o de *inversión superficial*.<sup>2</sup> Esto se hace utilizando los datos del sondeo vertical de temperatura. En el área en estudio se realizan sondeos de este tipo (dos veces al día) en las ciudades fronterizas estadounidenses de:

Brownsville, Tex.	El Paso, Tex.	Tucson, Ariz.
Yuma, Ariz.	San Diego, Cal.	

Las estaciones mexicanas de radiosonda más cercanas a la frontera se localizan a cierta distancia de la línea en:

Monterrey, N. L.	Chihuahua, Chih.
Guaymas, Son.	

#### *Frecuencia de las condiciones de aire estable*

En la Fig. 3, construida con datos de Hosler (1961), se puede apreciar que la mayor frecuencia de aire estable en la superficie, y por lo tanto de malas condiciones de difusión de contaminantes, ocurre en la estación invernal, cuando en la mitad poniente de la frontera (entre Tijuana y Ciudad Juárez) se presenta la mitad del tiempo una inversión de temperatura.

Hacia el oriente, en la cuenca media y baja del Río Bravo, la frecuencia del aire estable decrece hacia la costa reduciéndose ahí a un 35%.

En la estación calurosa (Fig. 3) se reduce la frecuencia de las inversiones o de aire estable a lo largo de la frontera, manteniéndose

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<sup>2</sup> CH. HOSLER, "Low-level Inversion Frequency in the U. S.", *Monthly Weather Review*, Vol. 89 (1961), 319-339.

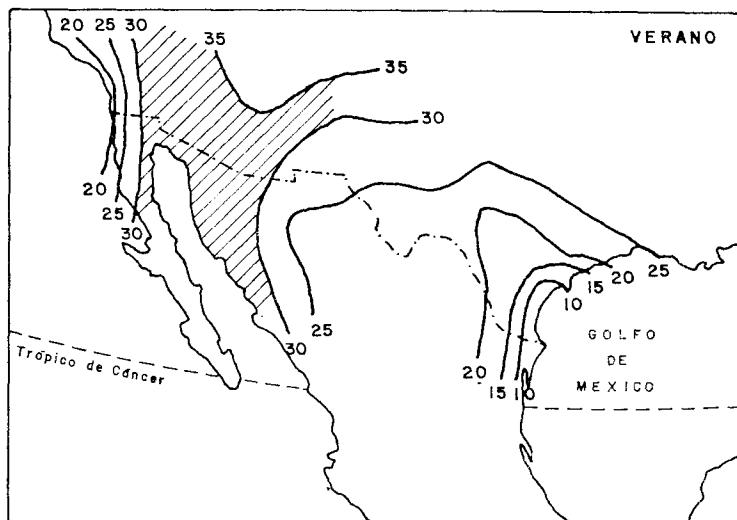
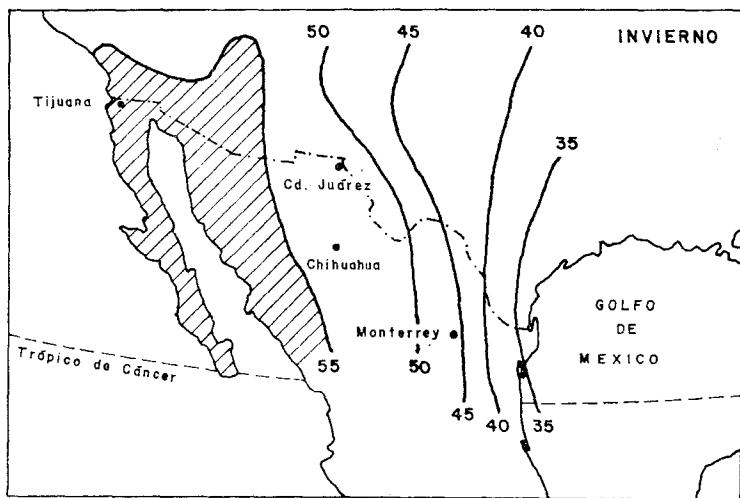


FIG. 3. FRECUENCIA DE LAS INVERSIONES SUPERFICIALES (en % del total de horas) EN LA FRONTERA (HOSLER, 1961).

una frecuencia máxima de 30 a 35% hacia el poniente de ésta, entre el valle del Río Colorado y la población de Agua Prieta en Sonora.

*Variación diurna de la estabilidad del aire superficial  
en la región fronteriza*

Ya se ha mencionado que la estabilidad del aire (el primer kilómetro) exhibe usualmente un ciclo diurno alcanzando su máxima inestabilidad (o mayor turbulencia) en las horas después del mediodía. En la Fig. 4, construida con datos de Hosler (1961), se muestra la variación diurna de la frecuencia de las inversiones superficiales de temperatura para cuatro horas del día (local) y en cuatro puntos de la frontera: dos en los extremos de ésta; Brownsville, Tex. y San Diego, Cal., y dos intermedios: El Paso, Tex. y Tucson, Ariz.

Conviene advertir que lo que se observa en las estaciones estadounidenses es válido en general para las poblaciones gemelas del lado mexicano. Se aprecia, en la Fig. 4a, que durante las noches y en las primeras horas de la mañana el aire es estable en el invierno entre un 60 y un 90% del tiempo, mientras que después del mediodía y por la tarde, la frecuencia de las inversiones decrece a un mínimo a lo largo de la frontera. Comparativamente, los extremos costeros de la frontera muestran una menor frecuencia de aire estable que la frontera-centro.

Durante el verano el aire es en general más inestable y turbulento en la faja fronteriza. Esto se puede ver en la Fig. 4b que muestra la variación diurna de la frecuencia de inversiones térmicas superficiales. Sólo en las mañanas de verano la frecuencia de inversiones es mayor de 60% (excepto en la costa del Pacífico, donde aun a esa hora el aire es rara vez estable). En el resto del día, la frecuencia de inversiones es mínima, indicando el carácter turbulento de la capa de aire superficial. En resumen puede concluirse que las condiciones de dilución atmosférica en la frontera muestran una gran variación diurna que va de "malas" condiciones en la noche y al amanecer a "buenas" después del mediodía.

*Variación estacional de la frecuencia de inversiones superficiales*

En la Fig. 5 se muestra la variación, a través del año, de la frecuencia del aire estable y, consecuentemente, de las condiciones adversas para la dilución de contaminantes atmosféricos, a lo largo del corredor fronterizo durante la salida del sol. En el tercio central de la frontera, el aire estable o las inversiones térmicas tienen una frecuencia mayor de 60% a través del año, siendo la región más continental, en Nogales-Tucson, donde el aire es más estable (entre 75 y 90% del tiempo). Este resultado era de espe-

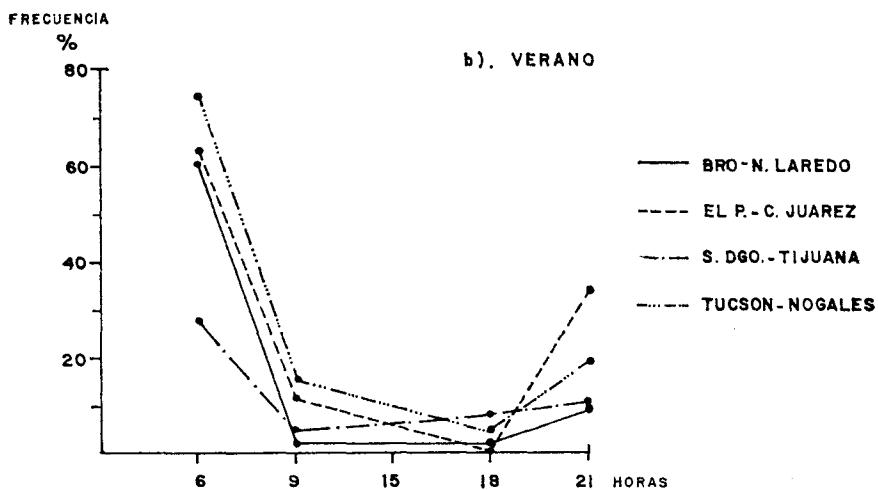
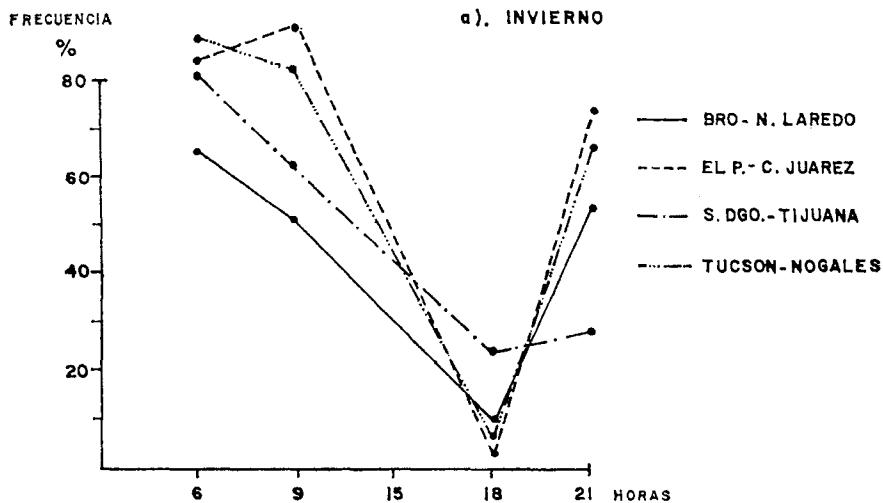


FIG. 4. VARIACION DIURNA DE LA FRECUENCIA DE INVERSIONES SUPERFICIALES EN LA FRONTERA NORTE. a). INVIERNO Y b). VERANO (con datos de Hosler, 1961).

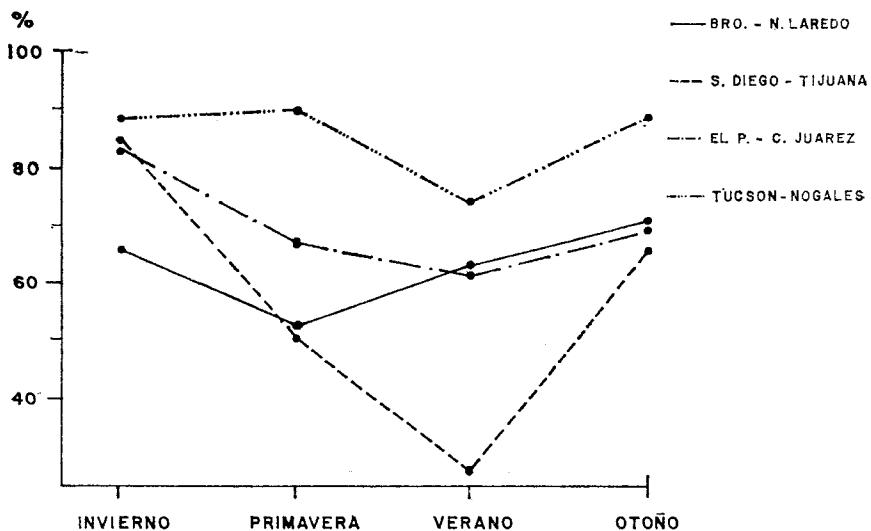


FIG. 5. VARIACION ESTACIONAL DE LA FRECUENCIA DE INVERSIONES TERMICAS SUPERFICIALES EN CUATRO PUNTOS DE LA FRONTERA (con datos de Hosler, 1961) A LAS 5 - 6 AM.

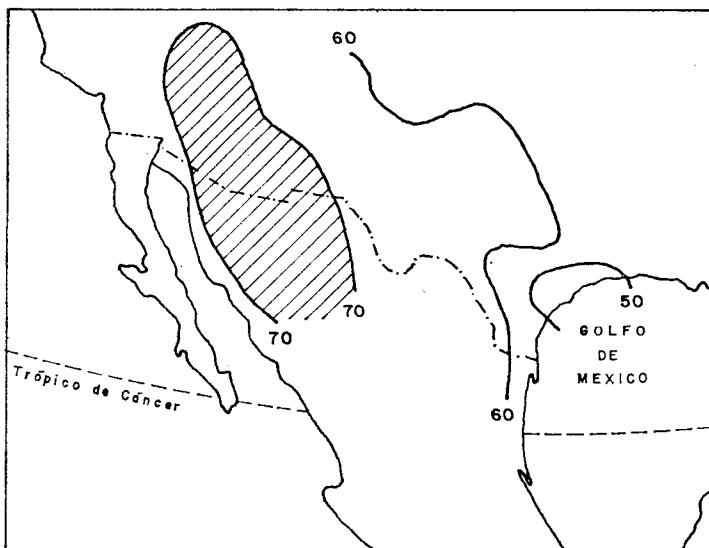


FIG. 6. FRECUENCIA ANUAL DE CICLOS DESPEJADOS ( $\geq 3/10$ ) EN LA FRONTERA (HOSLER, 1961).

rarse ya que dicha región fronteriza entre Arizona y Sonora-Oeste de Chihuahua, se caracteriza por una elevada frecuencia de noches casi despejadas que acentúan el enfriamiento del aire superficial por radiación nocturna, como puede verse en la Fig. 6.

#### *La profundidad de la capa de mezcla en la frontera*

Cuando los volúmenes de contaminantes atmosféricos son considerables es importante saber cuál es la extensión vertical de la capa donde se pueden mezclar durante el día. Mientras más profunda sea esta capa, mayor dilución se alcanzará y, consecuentemente, menor será el riesgo de que ocurran altas concentraciones de contaminantes. La mayor profundidad de la capa de mezclado se alcanza a la hora de mayor turbulencia convectiva, cuando la temperatura superficial es la más alta al mediodía. Esta profundidad máxima de la capa de mezcla (PMCM) es característica de cada lugar y se puede estimar utilizando los datos de los radiosondeos conjuntamente con la temperatura máxima. Los valores de la PMCM han sido estimados por Holtzworth (1964)<sup>3</sup> para los Estados Unidos y por Jáuregui (1979)<sup>4</sup> para México.

Con estos datos se han construido los mapas para enero y julio de la PMCM para la región fronteriza (Fig. 7).

#### *Verano*

Se advierte de la Fig. 7 que la PMCM en la frontera es mayor en la porción central de ésta, entre Nogales y Piedras Negras. Ahí, en el verano, la PMCM alcanza una altura de más de dos km. decreciendo hacia ambos extremos de la frontera. En la cuenca baja del Río Bravo la PMCM se reduce a unos 1,200 metros, mientras que en Sonora y Baja California la PMCM es la más baja de la frontera, particularmente en la región costera de Baja California.

#### *Invierno*

En la estación fría la PMCM se reduce considerablemente (Fig. 7a), lo que significa que son menos buenas que en verano las condiciones de dispersión de contaminantes atmosféricos en la vertical en la frontera.

<sup>3</sup> C. HOLTZWORTH, "Estimates of Mean Maximum Mixing Depths in the U. S.", *Monthly Weather Review*, Vol. 92: 5 (1964), 235-242.

<sup>4</sup> E. JÁUREGUI, "La Contaminación atmosférica potencial en los valles del centro de México", *Comunicaciones* (Proy. Puebla-Tlaxcala, N° 16) Puebla, 1979.

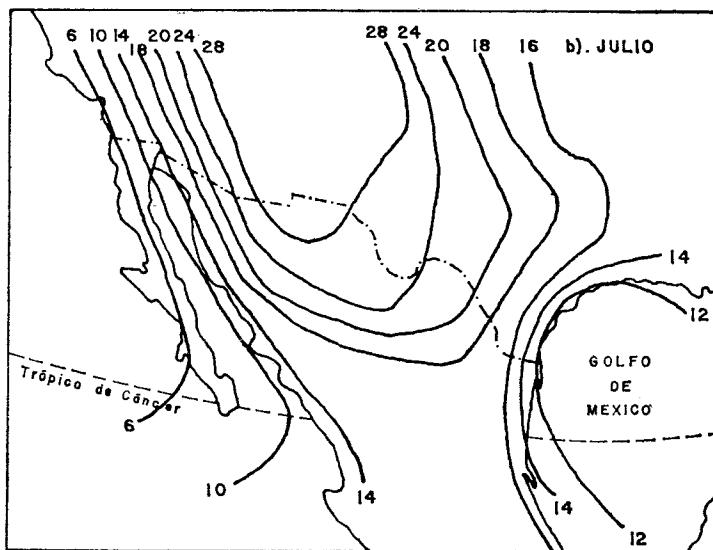
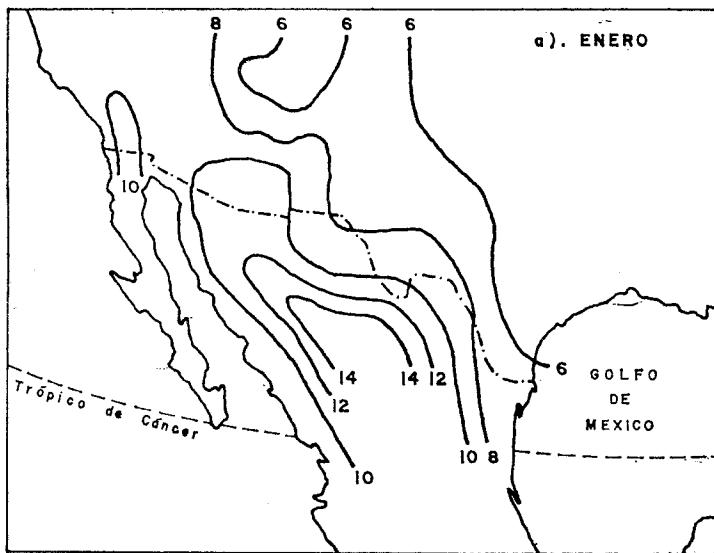
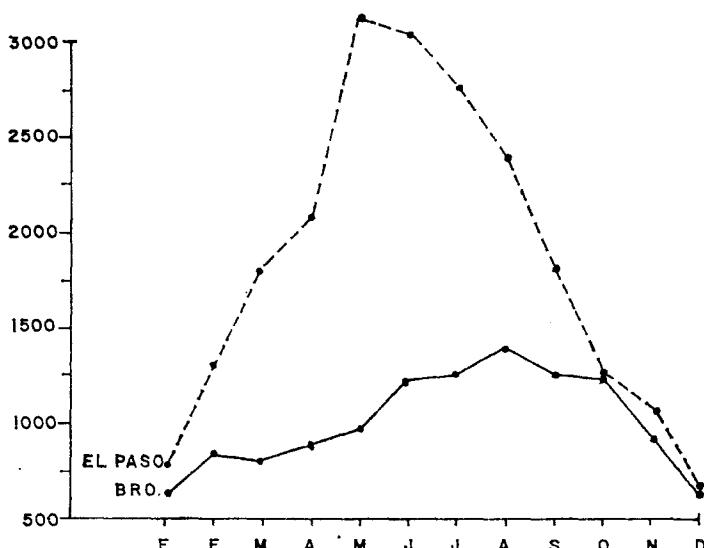


FIG. 7. LA ALTURA DE LA CAPA DE MEZCLA (en cientos de m.) EN LA ZONA FRONTERIZA. a). EN ENERO Y b). EN JULIO.

Durante esta época la PMCM varía de 800 a mil metros siendo máxima en la región de Agua Prieta a Sonoita, Son. En la Fig. 8 se puede apreciar que en la porción central de la zona fronteriza (en El Paso-Ciudad Juárez) la variación estacional de la PMCM es más acentuada (señalando el carácter continental del clima) que hacia la costa (en Brownsville-Matamoros), donde la influencia marítima se refleja en una menor variación estacional de la PMCM.

#### **EL TRANSPORTE HORIZONTAL DE LOS CONTAMINANTES AÉREOS EN LA FRONTERA**

En la sección anterior se ha visto cuáles son las características de difusión del aire de la frontera en la *vertical* de la llamada capa de mezclado. También se examinó la frecuencia de condiciones de aire estable o de inversiones superficiales de temperatura que restringen la dilución *vertical* de contaminantes atmosféricos.



**FIG. 8. VARIACION MENSUAL DE LA PROFUNDIDAD MAXIMA DE LA CAPA DE MEZCLA EN DOS PUNTOS DE LA FRONTERA.  
(datos de Holtzworth, 1964).**

En esta sección se describen las condiciones menos propicias para el transporte *horizontal* de las impurezas del aire en la faja fronteriza.

Como ya se vio en la sección anterior, la situación más desfavorable para la dispersión de los polvos y humos en la frontera es durante la noche y al amanecer, ya que es entonces cuando se presentan las llamadas inversiones de temperatura.

Si además de presentarse la condición anterior ocurren vientos muy débiles o aire en calma, entonces la situación se vuelve crítica, ya que los niveles de polución se pueden elevar peligrosamente, pues los contaminantes emitidos al aire ni se dispersan *verticalmente* (debido a la inversión) ni son transportados *horizontalmente* lejos de la fuente de emisión. En estas condiciones meteorológicas se han presentado los accidentes más graves de envenenamiento o deterioro del aire urbano.

Por esta razón es de interés determinar las áreas geográficas donde se presentan estas condiciones de aire débil o estancado.

En la Fig. 9, construida con datos de Hosler (1961), se muestra la distribución de la frecuencia de vientos débiles nocturnos (menos de 3 metros por segundo) para la región fronteriza. También se puede apreciar que la mayor incidencia de aire casi estancado en la noche, ocurre en la mitad poniente de la faja fronteriza, siendo ahí mayor la frecuencia de calmas en el verano (Fig. 9b). Esta área comprende el norte de Baja California y de Sonora, así como el oeste de Chihuahua.

En la porción oriental de la frontera disminuye marcadamente la frecuencia de aire estancado nocturno, sobre todo en el invierno (Fig. 9a), ya que es entonces cuando las masas de aire polar provenientes del norte, las cuales vienen acompañadas de fuertes vientos turbulentos, cruzan las llanuras de la cuenca media y baja del Río Bravo o Río Grande. Como contraste, la parte centro y poniente de la frontera, cruzada por el terreno abrupto de las sierras, ofrece mayor abrigo contra estos vientos del norte, debilitándose ahí el flujo del aire. El resultado es una mayor frecuencia de vientos débiles en dicha región durante el invierno (Fig. 9a).

En resumen puede decirse que el transporte *horizontal* de contaminantes aéreos es menos lento en la mitad oriente de la frontera; es decir, del SE de Ciudad Juárez-El Paso, hasta la desembocadura del Río Bravo o Río Grande.

#### UN PROGRAMA PARA EL ESTUDIO DE LAS CONDICIONES LOCALES DE DIFUSIÓN Y TRANSPORTE DE CONTAMINANTES EN LAS POBLACIONES DE LA FRONTERA NORTE

En las secciones anteriores se ha descrito el flujo general del aire y las propiedades de difusión de éste en el ambiente de toda la región fronteriza en general, desde el Océano Pacífico hasta el Golfo de México.

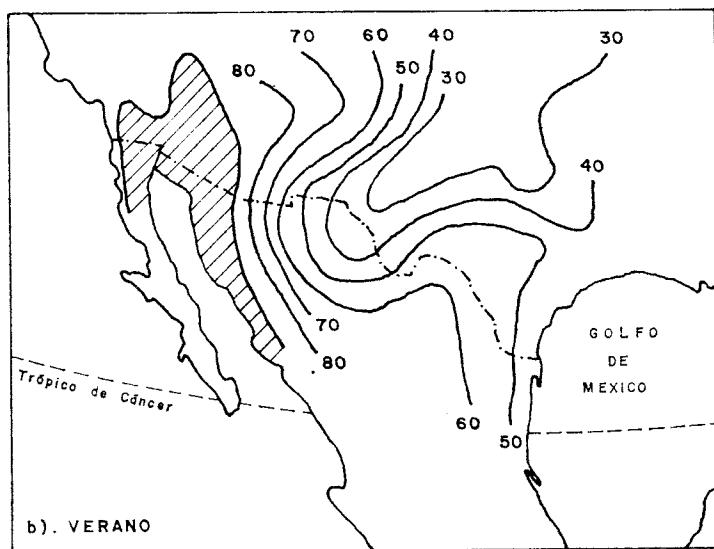
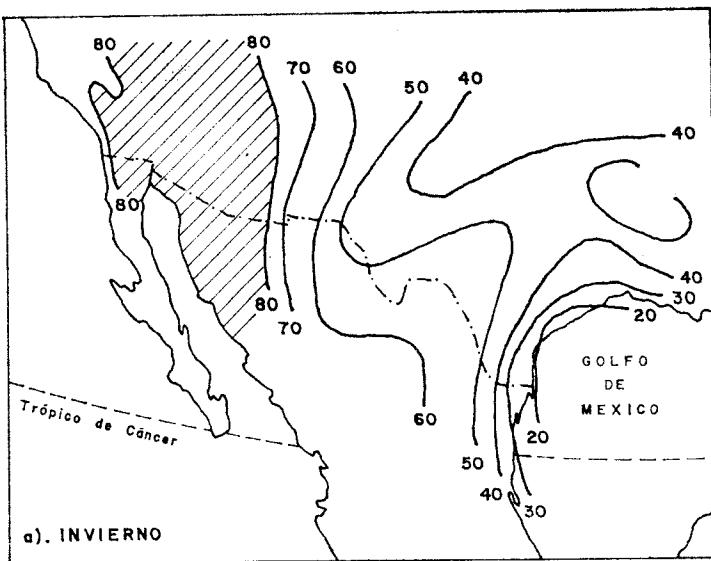


FIG. 9. FRECUENCIA (en %) DE CONDICIONES DE VIENTOS DEBILES ( $\leq 3 \text{ m/s}$ ) NOCTURNOS (HOSLER, 1961).

Se ha visto cómo estas características de dispersión de los contaminantes aéreos varían de una porción de la frontera a otra, según se trate de la región montañosa central o de las áreas más oceánicas. El siguiente paso en el estudio de las propiedades atmosféricas para dispersar impurezas sería abordar con mayor detalle la descripción de casos particulares de algunas de las localidades urbanas fronterizas.

Lo primero que se ocurre es comenzar por las grandes ciudades de la frontera tales como Ciudad Juárez y Tijuana cuya población, sumada a la de la ciudad gemela estadounidense correspondiente (El Paso y San Diego), sobrepasa el millón de habitantes. Es en estos dos grandes núcleos urbanos (seguidos de Mexicali-Caléxico) donde son evidentes, en mayor o menor grado, los problemas del deterioro de la calidad del aire. Seguirán en este estudio, de las condiciones locales de difusión atmosférica, las ciudades fronterizas de tamaño mediano como San Luis Río Colorado, Matamoros, Reynosa, Nuevo Laredo y Nogales, donde las fuentes urbanas de contaminación aérea no son actualmente muy numerosas.

Finalmente se abordará el estudio de difusión del aire en las localidades fronterizas pequeñas, donde el riesgo de deterioro de la calidad del aire es actualmente insignificante.

### *Los datos meteorológicos básicos*

Los factores del clima que más interesan para este tipo de estudios son: el viento (dirección y velocidad), la nubosidad, la temperatura y la humedad.

En la actualidad se cuenta con observaciones horarias de los elementos climáticos mencionados en cinco localidades fronterizas que tienen aeropuerto como son:

Tijuana  
Reynosa

Mexicali  
Nuevo Laredo

Ciudad Juárez

Una mirada a la ubicación de estas poblaciones permite apreciar que todavía quedan grandes extensiones de la frontera que no cuentan con estaciones climatológicas necesarias para este tipo de estudio, como son los trechos de Nuevo Laredo a Ciudad Juárez (mil km.) y de Ciudad Juárez a Mexicali (unos 800 km.). Es cierto que parte de esta escasez de información climatológica se puede suplir con los datos que se generan en algunos puntos del lado estadounidense, tal como se ha hecho en este trabajo para elaborar las secciones anteriores. En todo caso, sería deseable que los datos climatológicos que se producen en ambos lados de la divisoria fueran de fácil acceso para los investigadores de estudios de la frontera de ambos países.

*Datos climatológicos complementarios*

Además de la información climatológica horaria de los aeropuertos (que es sin duda la más completa para estos fines) funcionan en la frontera estaciones climatológicas de segundo orden donde se registran una vez al día algunos datos meteorológicos complementarios para este tipo de estudios tales como la temperatura (máxima y mínima), la lluvia, etc. El viento, que es un dato importante para nuestros propósitos, se reporta en forma muy imprecisa en este tipo de estaciones: a la hora de la observación (las 8 a.m.) se anota la dirección del viento por medio de una veleta y se estima su intensidad según la escala de Beaufort. Además, se anota la dirección del viento que prevaleció en las últimas 24 horas, dato que generalmente es de poca precisión. Aun con las limitaciones mencionadas, la información de estas estaciones (manejadas por el Servicio Meteorológico Nacional de la SARH) vecinas a la frontera puede ser de utilidad (Tabla 1).

**Tabla 1**  
**RELACIÓN DE ESTACIONES CLIMATOLÓGICAS  
EN LA FRONTERA NORTE**

<i>BAJA CALIFORNIA</i>	<i>Años de observación</i>
Col. Juárez (Mexicali)	13
Rosarito (Tijuana)	8
Bataques (Mexicali)	27
Presa Morelos (Mexicali)	14
El Compadre (Mexicali)	17
La Puerta (Mexicali)	14
La Rumorosa (Mexicali)	27
Mexicali (Mexicali)	30
Presa Rodríguez (Tijuana)	27
Tecate (Tecate)	12
Tijuana (Tijuana)	27
Valle de las Palmas (Tecate)	27
Valle Redondo (Tijuana)	5
 <i>SONORA</i>	
El Riito (Sonora)	26
Nogales (Nogales)	4

**Tabla 1** (*continuación*)

	<i>Años de observación</i>
Naco (Sonora)	11
Cananea (Sonora)	14
Caborca (Sonora)	4
San Luis Río Colorado (Sonora)	26
Sonoita (Sonora)	26
 <i>CHIHUAHUA</i>	
Banderas (Chihuahua)	12
Ciudad Juárez (Chihuahua)	3
San Agustín (Chihuahua)	3
Vaso Sauzal, Juárez	3
Ojinaga (Ojinaga)	7
Presa Tarahumara	2
Santa Elena (Chihuahua)	8
 <i>COAHUILA</i>	
Acuña	6
Palestina	31
 <i>TAMAULIPAS</i>	
Camargo	22
Miguel Alemán (San Pedro)	22
Díaz Ordaz	22
Reynosa	22
Río Bravo	24

Se advierte de la tabla que las estaciones climatológicas están desigualmente distribuidas a lo largo de la línea fronteriza. Del total de 34 estaciones termo-pluviométricas, la mayoría (el 38%) se localizan en Baja California, es decir, en el estado con el trecho más corto de frontera. Sonora y Chihuahua tienen un número igual de estaciones (7) en la divisoria, mientras que Tamaulipas y Coahuila se encuentran al final de la lista.

Es muy probable que del lado estadounidense funcione cuando menos un número igual de este tipo de estaciones climatológicas de segundo orden. De ser así, sería deseable contar con dicha información para la elaboración de estos estudios ambientales.

*Los datos de muestreo del aire*

Lo que se ha dicho en relación con los datos climatológicos en la frontera es también válido para la información sobre mediciones de la calidad del aire en esta región. Del lado mexicano sólo se cuenta con mediciones esporádicas de algunos de los contaminantes atmosféricos, principalmente polvos.

Sólo recientemente, a partir del año 1979, en la ciudad de Tijuana se ha comenzado a muestrear en forma sistemática el aire para partículas totales en suspensión.

En Ciudad Juárez, que junto con El Paso forma el área metropolitana más importante de la frontera, el monitoreo del aire data de 1972 (Dávila, 1972).<sup>5</sup> La red de muestreo del aire en Ciudad Juárez consta de 4 estaciones que toman muestras de polvo total y después los filtros son analizados para determinar el benceno soluble. Otros contaminantes muestreados en Ciudad Juárez, con una red mayor (20) de puntos de muestreo, han sido los compuestos de azufre cuya medición data del año 1972.

Esta información ha sido tomada del informe del Consejo Bi-Nacional de Salud El Paso-Ciudad Juárez (1975)<sup>6</sup> donde se publican por primera vez los resultados del muestreo del aire en Ciudad Juárez-El Paso. Esta publicación representa un primero y bello esfuerzo mancomunado de las autoridades sanitarias de ambas ciudades fronterizas para obtener información básica sobre la calidad del aire en el área Ciudad Juárez-El Paso.

En el momento actual carecemos de información sobre la existencia de otras redes de monitoreo en ciudades gemelas fronterizas menores.

**LOS ESTUDIOS DE CONTAMINACIÓN DEL AIRE EN LA FRONTERA**

Aun cuando los datos ambientales son todavía insuficientes, conviene mencionar que han aparecido ya algunos estudios de polución atmosférica realizados en Ciudad Juárez-El Paso por científicos de

<sup>5</sup> G. DÁVILA, "Joint Air Pollution Monitoring Program Developed in Ciudad Juárez-El Paso", en Applegate y Bath, editores, *Air Pollution Along the United States-Mexico Border* (The First Bi-National Symposium on Air Pollution, University of Texas at El Paso, Sept. 1973), El Paso, Texas Western Press, 1974.

<sup>6</sup> El Paso-Ciudad Juárez Binational Health Council, Environmental Health Subcommittee, "Progress Report on Air Pollution Survey in El Paso-Ciudad Juárez, 1972-1974", Preliminary Draft, 1975. Mimeógrafo.

ambos países (Ordóñez *et al.*, 1976;<sup>7</sup> Hubert *et al.*, 1981;<sup>8</sup> Quevedo, 1977)<sup>9</sup> en relación con el problema de la contaminación aérea que produce una planta metalúrgica de El Paso, en ambos lados de la divisoria.

Si bien estos estudios se han limitado al problema de la contaminación del aire por plomo en Juárez-El Paso, problema que, entre paréntesis, parece ser que después de ocho años no ha podido resolverse hasta el presente (ver Applegate, 1981), dichos estudios constituyen un buen inicio para ampliar la investigación a otros contaminantes de esa área fronteriza.

Existe además un trabajo preliminar de los aspectos meteorológicos de la contaminación del aire de la cuenca aérea Tijuana-San Diego (Jáuregui, 1979;<sup>10</sup> 1981)<sup>11</sup> y, en la actualidad, se colectan y procesan los datos climatológicos y de contaminación para aquellas poblaciones fronterizas mexicanas que cuentan con información.

#### COMENTARIOS FINALES

Sería deseable que reuniones como la presente ayuden a crear un campo propicio para la realización de estudios ambientales relativos al aire en la frontera, mediante:

*a)* Creación de un banco de datos climatológicos de la frontera formado con:

- estaciones de radiosondeo
- observatorios meteorológicos
- estaciones meteorológicas de aeropuertos
- estaciones termo-pluviométricas secundarias

*b)* Establecimiento (o ampliación) de redes mínimas de monitoreo (tres o cuatro estaciones) de los principales contaminantes (polvos, O<sub>3</sub>, metales pesados, SO<sub>2</sub>) en áreas urbanas de ambos lados de la frontera.

<sup>7</sup> B. ORDÓÑEZ, L. R. ROMERO y R. MORA, "Investigación epidemiológica por contaminación de plomo en Ciudad Juárez en relación con una fundición de El Paso", *Bol. Ofna. Sanitaria Panamericana*, 80: 303 (1976).

<sup>8</sup> J. HUBERT, R. CANDELARIA, B. ROSENBLUM y H. APPLEGATE, "A Survey of Ambient Air Levels of Lead in El Paso, Tex.", *J. Air Pollution Control Association*, Vol. 33: 3 (1981), 259-262.

<sup>9</sup> H. QUEVEDO, "Concentration and Distribution of Lead in the Air of Ciudad Juárez", Phd. Dissertation, University of Oklahoma.

<sup>10</sup> E. JÁUREGUI, "Climatología de difusión de la ciudad de Tijuana, B. C.: Informe Técnico", Dir. Gral. de Saneamiento Atmosférico; Sub-Sra. Mejoramiento del Ambiente, 1981.

<sup>11</sup> E. JÁUREGUI, "Air Pollutant Transport in the Tijuana-San Diego Basin", *AAG Abstracts*, Annual Meeting Association of American Geographers, Los Angeles, Calif., April, 19-22, 1981.

Conviene hacer notar que en los dos pares de ciudades fronterizas gemelas más grandes (Tijuana-San Diego y Ciudad Juárez-El Paso) la situación a este respecto deja todavía mucho que desear ya que existe un volumen mucho mayor de datos climatológicos y de muestreo de contaminantes del lado estadounidense, mientras que del lado mexicano dicha información, tan necesaria para este tipo de estudios ambientales, es mínima y esporádica.

c) Experimentos de difusión atmosférica por medio de gases trazadores en cuencas aéreas fronterizas, con objeto de definir las trayectorias más probables o frecuentes de los contaminantes dentro de las áreas urbanas de la frontera.

#### **CONCLUSIONES**

El problema del deterioro de la calidad del aire tiene dos aspectos:

- a) la intensidad y distribución de las fuentes (fijas y móviles) de emisión de contaminantes.
- b) las condiciones meteorológicas que facilitan o restringen la dispersión de las impurezas.

En el presente trabajo se examinan los aspectos meteorológicos de la contaminación del aire a lo largo de la frontera norte de México. Las propiedades de difusión del aire muestran variaciones (como en otros lugares) diurnas y estacionales. Las situaciones desfavorables para la dispersión de contaminantes aéreos en la frontera ocurren particularmente en la estación fría y, sobre todo, en el trecho montañoso de la divisoria donde la frecuencia de inversiones superficiales es elevada.

Se describen también las variaciones que en la frontera sufre la profundidad máxima de la capa de mezcla (PMCM) que guardan una relación estrecha con la capacidad de dilución del aire en *la vertical*. Asimismo, se examina la frecuencia de vientos débiles nocturnos a lo largo de la frontera para estimar las variaciones de la capacidad de transporte de contaminantes en *la horizontal* a lo largo de la frontera.

Finalmente se señalan los principales puntos para abordar el estudio, a escala local, de las características de difusión y transporte del aire urbano y su relación con los niveles de contaminación en las principales ciudades de la frontera.



## TRANSNATIONAL AIR POLLUTION

HOWARD G. APPLEGATE

### INTRODUCTION

Air pollution along the United States-Mexico border neither is due exclusively to the activities of man nor a recent phenomenon. Some years ago, a chemical industry in the Lower Rio Grande Valley asked me to investigate damage to vegetation. Local residents were blaming the damage on emissions from the company. In fact, the damage was due to an onshore breeze carrying droplets of sea water several miles inland and depositing sodium chloride on the vegetation. This meteorological condition occurred many times in the past and will occur many times in the future. To plant lovers, it is a form of pollution.

The central area of the border —El Paso/Ciudad Juárez— and the far western portion —San Diego/Tijuana— are characterized by temperature inversions. Anything put into the air during these inversions cannot disperse. The pollutants, whether from modern industry or campfires of prehistoric Indians, obey the laws of physics and remain around until the inversion breaks.

The activities of modern man —in procreation, occupation and recreation —have accentuated the age-old problem. It is truly a transnational problem. Heavy metals and carbon monoxide move freely within the El Paso-Ciudad Juárez airshed (Applegate, 1981*a, b*). A single particle or molecule may criss-cross the border several times constrained only by topography and the laws of fluid mechanics. Until recently, the aerial degradation was conceived of as a "social disutility" —a vague term denoting a dimensionless cost somehow borne by the public-at-large. Lately, public demands north of the border that aerial degradation be halted, changed the social disutility to an "economic disutility", i. e., pollution represents a cost which must be first quantified and then charged to someone. South of the border, aerial pollution is still viewed as a social disutility to a large degree. Herein lies the transnational problem: social disutility vs. economic disutility. Complicating this transnational problem is that neither nation, within their own boundaries,

has come to grips with their own national problem of the social and economic costs of utilizing their atmospheric resources.

The atmosphere has been cited, for many years, as the classic example of a common property resource (CPR). It belongs to no one, so therefore belongs to everyone. To early economists, air was more than a CPR; it was a free good, i. e., enough for everyone and no one would pay for a bigger share. Common law, however, put yet a third interpretation on air —real property held under title of fee simple absolute. This gives one exclusive right to use the air over one's property for whatever purpose. Simply put, if the air you own and have polluted moves over my property, it is now my air and my property for my use. As receptor and owner of your former air, I have the legal right to demand you take from your air any pollution you put into it before the air crossed your property line and became my air.

A problem arises in that I can fence off my land from your land and my water from your water but I cannot separate my air from your air. The indivisibility of air —be air regarded as a free good, a CPR, or as real property— makes the resolution of aerial pollution most difficult.

Ignoring the indivisibility of air for the moment, the property line between "your air" and "my air" can be between private parties or international states. In both situations, to resolve disputes, there are common and well-recognized steps that must be taken. First, legislative bodies must assume jurisdiction over the dispute; secondly, judicial systems must agree the legislative jurisdiction is within permissible limits; thirdly, an administrative infrastructure with regulatory powers must be created; lastly, monitoring of individual effluents and ambient air quality must be done.

Both the United States and Mexico have taken the above steps in dealing with national air pollution problems. Both countries have established ambient and effluent standards. [An ambient air standard is a legal specification of minimum conditions which must be met for some pollutant at a specified site. An effluent air standard specifies a permissible discharge of a pollutant from a point source.] What has not been done is to reach mutual agreement on social vs. economic disutilities, utilization of a CPR, and the right to use real property which is difficult to demarcate. This paper will explore these three areas.

#### THE PUBLIC AND AIR POLLUTION

Long (1971) states "that a major problem [air pollution] appears only when a certain critical level of pollution is attained. Below that threshold, nature (often referred to as the 'environment' or the 'ecological system') can assimilate, i. e., chemically convert most of the noxious

wastes emitted by the industrial process". This statement is true in a technical sense only. Air pollution does become a health problem only when the assimilative powers of the atmosphere become overwhelmed; however, before the problem can be addressed, it first must be formally recognized as a problem.

Ordóñez (1978), former Jefe, Area Salud del Programa de Mejoramiento Ambiental de México, declared that there was no correlation between air pollution and respiratory disease in Mexico. The entire rest of the world has found a close relationship between air pollution and respiratory disease (Shey, et al., 1978).

In the city of Cubatao, Brazil, 40 of every 1,000 babies are still births; another 40 perish within the first week of birth (*El Paso Times*, 1980). A majority of the victims are deformed. The 1,295 square kilometer area is bombarded daily by 429,096 kilograms of carbon monoxide, 165,106 kilograms of sulfur dioxide, 134,262 kilograms of particulate matter, 37,194 kilograms of nitrogen oxide and 28,122 kilograms of hydrocarbons. The managing director of the foundry located there made the following statement:

Foundry work is unavoidably polluting work, and is no longer accepted by highly unionized workers of the so-called developed countries. As is well known, in the developed countries an extremely strong emphasis —I don't say if correctly or not—is placed on the pollution problem. In view of these considerations, the iron foundry is a activity more suitable to third world countries.

The foundry is owned by Fiat of Italy. Cubatao has one of the highest number of still-births in the world. It also has the highest per capita income of any city in Brazil. Obviously, exceeding the assimilative capacity of the atmosphere does not in itself constitute a recognizable problem.

It is the middle economic class that recognizes the problem and thus constitutes the most vociferous force in battling pollution. The lower economic class is too busy trying to secure the basic necessities of life to worry about pollution; the upper economic class simply moves away from the pollution. All economic classes have an ordered hierarchy of wants; food, clothing, and shelter rank highest in this hierarchy and primary economic activities are devoted to satisfying these wants. Once these wants are substantially fulfilled (not necessarily satiated), lower ranking wants will increase in relative value.

The fact that a certain level of income must be reached before air pollution is recognized as a primary problem, suggests it is a superior economic good, i. e., varies directly with real income (Crocker, 1968).

This gives rise to a seeming paradox: the higher the real income, the more consumption; the more the consumption, the greater the air pollution to produce the goods; the greater the air pollution, the higher the real income. The tragedy or perverseness of this association is that neither the health effects, nor the income are distributed equally: the poor get the pollution and the rich get the income.

We must differentiate between actual air pollution and potential air pollution. Actual air pollution is what is emitted now; potential air pollution is what could be emitted sometime in the future if  $x$  number of units of something were to be produced.

Actual air pollution and real per capita income increase together to a point. With the increase in real per capita income comes increasing satisfaction of the basic necessities of life and increasing dissatisfaction with air pollution. As personal priorities are adjusted, air pollution will assume even more importance. When enough people reach this point, they will demand that air pollution be curtailed. Thus actual air pollution must increase along with increasing affluence before the public will demand less potential air pollution and thus have cleaner air in the future.

The differences in real per capita income between the two sides of the border are well documented. As per capital income increases south of the border, the concept of air pollution as a social disutility will give way to the concept of pollution as an economic disutility. The best way to speed up the change is to speed up the increase in per capita income.

#### ECONOMICS AND AIR POLLUTION

The concept south of the border of air pollution as a social disutility makes it difficult to discuss economic values. The preliminary portion of this section will be devoted, therefore, to conditions north of the Rio Grande; the later portion will deal with the prospects of the southern portion of the borderland changing their economic viewpoint — or rather, how quickly they will change their viewpoint.

In the United States, air can no longer be considered a free good if indeed, it ever was a free good. As long as the value of retention costs is greater than the value of retention benefits for present or potential pollutant emissions, there is no economic incentive to use anything but the air's waste disposal abilities. Under fee simple rights, this can be done. The law recognizes this right by measuring ambient concentrations of pollutants outside an industry's property line and not on the property itself. [Effluent emissions are usually measured in stacks. Industrial areas between the stack and the property line do not exist for the EPA.] Obviously, we must make the value of retention costs less

than the value of retention benefits to eliminate using the air's waste disposal abilities.

One established strategy has been to increase the cost of the polluter, i. e., non-retention becomes a disutility or disbenefit by being subjected to fines. Needless to say, the method has many drawbacks. There are technical ones: proving the pollutant comes from plant A and not plant B; proving plant A has indeed installed the best available control equipment and not the cheapest control equipment. Within a single plant, there is no incentive to minimize control costs for the plant as a whole by modifying input vs. controlling effluent since each point is considered separately from all other point sources.

Legal problems also plague standards-based regulatory programs. The setting of the standards themselves is a long and difficult process involving both legislative and judicial processes — often overlayed with a pseudo-medical facade. Once the standards are established, an individual industry has many economic disincentives to delay meeting the standards as long as possible. The chief disincentive is the annualized cost of installing and operating abatement equipment. This cost is passed on to the consumer and could place the individual firm in an unfavorable position vis-à-vis competitors. Implicit in the regulatory process is the concept that the regulatory agency has perfect knowledge of the industrial process—an obvious impossibility. Anderson, *et al.* (1977), discuss the problems of standard-based regulatory program in detail.

Costle (1980) announced a new concept in "New Ways to Regulate: The Bubble Policy" — an effort to give companies economic incentives to clean their aerial effluents. Originally, the concept applied only to single plants. A bubble with a single stack was conceived as covering the plant. Effluent standards applied only to the single stack and not to the several, individual emission sources within the bubble. The plant manager would make decisions as to which source would be controlled and what mix of control measures would be used in order to meet emission standards. Plant managers would find it economically advantageous to control most completely those sources having the least costly control technologies and thus have fewer costs to pass on to the consumer.

From this single plant control, the concept has been expanded to place the bubble over an entire air-quality-control region (airshed). In place of individual sources within a single plant, there are now individual plants within a single airshed. A plant manager can make decisions within his own plant; between plants, however, there must be some way to decide which plant pollutes and which plant cleans up and how much of each is done. This introduces the concept of pollution permits.

The use of pollution permits is gaining wide acceptance (Tietemberg, 1974; White, 1976; Anderson, *et al.*, 1977; Russell, 1981); however, for a negative point of view, consult Liroff (1980). Simply stated, plant A

must reduce pollutant B. This can be done in several ways: reduce its own emission of B; if it is more cost effective, pay for equipment to reduce emissions of B from plant C and utilize the "clean" air for its own emissions; buy up all the pollution permits of plant C (and close it) and utilize all the "clean" air for its own use. Obviously, there are many problems in the implementation of this policy. Most economists agree, if implemented, it would be a movement toward least-cost distribution of meeting ambient, effluent, or airshed standards. Most importantly, for the purpose of those interested in air pollution along the border, we have, for the first time, a concept that ignores political boundaries.

#### SOLVING THE PROBLEM

The Subsecretaría de Mejoramiento del Ambiente was formed in 1971 and first met with the Environmental Protection Agency in 1972. Applegate (1981c) details the meetings, agreements, and accomplishments. The accomplishments were best summed up by Dr. Manuel López Portillo, SMA, and Mr. Douglas M. Costle, EPA, on November 20, 1980 when they stated there was "little to show in terms of meaningful accomplishments" in improving the border environment. Later, in another paper, Applegate (1981d) argued that since neither federal government could resolve the issue, local authorities with their more pragmatic approaches should play a major role in resolving transnational environmental problems. Methods to be outlined below could be the first steps in that direction.

Mexico law recognized the atmosphere as a CPR as does the United States law. The law of Mexico goes one step further: the atmosphere belongs to the state — *res publicae*. In the United States, the atmosphere is held in common — *res communes*. In Mexico, the state has claimed outright ownership; here, the state has appointed itself as trustee of something owned by everyone.

In both countries, the state claims the authority to lay down terms upon which the CPR can be used. Both countries have been diligent in seeing the CPR was used to return a profit to the users and a revenue to the states. Neither state, until recently, was interested in placing restrictions upon entities individuated in the CPR. Thus, the entities could establish private rights or they could use the CPR without bothering with the expense of a private appropriation. A government will only resist such usage when social policy sees a value in so doing. Once such a value has been determined, the government can establish an entitlement to the CPR.

The entitlement in Mexico is the government; in the United States, the entitlement belongs to an undefined "public". In economic theory, the

Mexican state can set a value on the use of their atmosphere since it is owned by an entity. Being owned (entitled) it has a potential value. In the United States, the atmosphere is owned by everyone and hence by no one. It is difficult to set a value, actual or potential, on something owned by no one. The first step, therefore, should be for the federal government of the United States to establish an entitlement to the atmosphere.

There is precedent for this action. Movement of planes and propagation of radio and television waves through the atmosphere are all controlled by the federal government. If the federal government does not want to obtain entitlement to the atmosphere of the entire nation, there is precedent for a law giving them entitlement to the border air. Laws applying only to the border region govern the border patrol, customs, immigration, right-of-search, etc.

If both governments have entitlement to the atmosphere then air on both sides of the border are no longer CPR's but PPR's — public property resources. They have values like any other PPR — national forests, grazing lands, public buildings, etc. Now the two governments can use the market place to provide incentives for clean air along the border — after Mexico recognizes the bubble concept over an airshed.

The bubble concept in the United States applies to an air-quality-control region, i. e., an aerodynamic area. City, county, and state boundaries can be ignored. In theory, international boundaries can be ignored — if both nations agree. To treat an airshed as a single entity is scientifically correct, technologically feasible, and politically acceptable. The scientific correctness and technical feasibility of such an action should be self-evident. If the two governments are seriously interested in dealing with aerial pollution along the border, such an action should be politically acceptable since it will help the economy of both countries. Let us consider a concrete example.

*Maquiladoras* have contributed greatly to Mexico's economy (Hansen, 1981). Their importance was demonstrated recently when a medium-sized firm shut down in Cd. Juárez. The governor of Chihuahua, in an effort to retain the jobs, "loaned" the workers money to purchase the plant. The "loan" is to be repaid from profits the firm earns in the future. This is but one of many examples that could be cited of official Mexican efforts both to obtain and to retain the *maquiladoras* that are of such great economic importance to them. (It is not relevant to this discussion that the plants are owned by interests north of the border. Mexican officialdom zealously protects them as though they were Mexican owned.)

Electronic assembly plants play an important role in Cd. Juárez and Nogales. North of these cities, in an area stretching from El Paso to Ajo,

about 18 percent of all the sulfur dioxide in the United States is emitted (Shoultz, 1974). This has caused corrosion problems at the assembly plants. Some have installed elaborate and expensive filters to remove the compound from the air. Folklore says that at least one such firm put a plant elsewhere than on the Mexican border due to the problem. Let us draw up a scenario that could happen if the United States government has entitlement to the atmosphere north of the border and the Mexican government accepted the bubble concept south of the border.

The sulfur dioxide emitters (chiefly smelters) would face policing by both governments, since the electronic plants would have access to both governments. Obviously, a cost-effective study would be done on what combination of methods would reduce sulfur dioxide levels in the bubble to a level acceptable to all. The emitters and receptors are bound together under a bubble of air and not separated by an international boundary. Thus they have an incentive to find, by their mutual efforts, the cost-effective solution. We have internalized costs previously externalized, provided economic incentives that replace altruistic impulses and replaced unilateral decision-making with a system of viable international give and take.

It is axiomatic that the cost of cleaning air is exponential, i. e., the cost of cleaning up 90 percent is about equal to the cost of cleaning up the remaining 10 percent. The emitters may find it cost effective to clean up less than 90 percent and pay to install, in the receptors, equipment that will filter their incoming air. Similarly, the receptors may find it cost effective to filter their air less and spend money helping the emitters reduce their emissions.

Both governments, since they own the air, would be encouraged to have input into the negotiations. They will be concerned with tax revenues, contributions to the local economies, and GNP's. Money criss-crosses the border as frequently as do emissions.

Obviously, there are many variables to play with in achieving the least cost-effective methodology of meeting the air standard. Thus there will be great flexibility in methodologies. Of great importance, is that air south of the border will no longer be a social disutility; it will be an economic disutility when polluted.

Both governments will also be dealing both legally and economically with a PPR and not with a CPR. This will greatly simplify not only their dealings with each other (which would be minimal) but also with industry. Industries both north and south of the border have dealt with their respective governments for use of PPR's such as grazing land, forests, minerals, and waters. The legal and economic bases for such dealings have been well established. This will facilitate the establishment of a fair market price for the use of the atmosphere.

We have also, by using the bubble, done the "impossible" — divided the indivisible. The border atmosphere is indivisible; airsheds are discrete areas having singular characteristics within the atmosphere. Airsheds within the border atmosphere are Lower Rio Grande Valley; El Paso-Ciudad Juárez; Douglas-Agua Prieta; Nogales-Nogales; Calexico-Mexicali; San Diego-Tijuana. Within each airshed, individuation, pollution-permit exchange, and market values can be established independent of any other airshed.

d'Arge and Kneese (1980) have written what is considered a classic paper on international environmental degradation and economics. Let us examine these two proposed actions from the viewpoints expressed in their paper. They state:

First, environmental externalities have arisen because... [they]... are resources without defined ownership rights or rights of use. These resources are viewed as being commonly owned or not owned at all. A nation that agrees to a particular pattern of ownership could potentially lose some of its implicitly controlled resources and thereby decrease its national wealth.

First, we propose that the border air no longer be a CPR but a PPR. It is owned by the states. The states can isolate their own PPR as they choose. This is already the case in Mexico; the United States needs to take action to assume ownership of the air. Once this is done, both national governments can identify selected portions of the individual airsheds, for aerial degradation purposes only, and assign them as a responsibility of a binational agency. Neither government loses any of its aerial resource; quite the opposite, both governments increase a national resource by gaining shared control over a previously foreign-owned resource. Thus both governments increase their potential wealth.

d'Arge and Kneese discuss the polluter-pays (PP) principle (the emitter pays for amelioration measures but not for residual damage); the full-cost (FC) principle (emitter pays for control costs plus residual damages); victim-pays (VP) principle (receptor pays emitter for control costs and absorbs all residual damages) and the common-property-resource institution (CPRI) principle (states give powers to an autonomous agency to regulate the use of a CPR). They point out that given certain simplified conditions, in bilateral cases, PP, FC, and VP are theoretically symmetrical and produce Pareto efficiency in the short and long runs if consumers and production factors are immobile internationally. These conditions would be met in the bubble, certainly for *maquiladoras*, and probably for most emitter-receptor border industries.

Throughout their discussion, d'Arge and Kneese use an adversarial confrontation scenario. They quite correctly point out that this could

lead to exaggeration of claims and thus to economic inefficiencies. Under the bubble concept, exaggeration of claims only harms the exaggerator. It is to everyone's economic advantage to state a fair case in seeking cooperative measures with other industries within the bubble rather than employ adversarial confrontations.

Finally, they discuss the problem of information and transactions costs. Once again, their point is that if nations do this, there are many imponderables and difficulties. Virtually all are due to CPR "ownership" and a standards-based regulatory program. Most of the cited difficulties would disappear if border air was a PPR under a bubble-based regulatory program.

Some type of a binational administrative structure would have to be established for this program. It could be an entirely new one or the program could be placed in a present administrative structure. Bath (1977) has discussed various options that might be employed. Whatever the administrative structure, industry on both sides of the border would find it economically feasible to work together to solve common problems.

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## COMENTARIO

JOSÉ MARÍA CALDERÓN RODRÍGUEZ

...el hombre es un vagabundo en medio del viento, de la arena y las estrellas. La *terre des hommes* de St. Exupéry comienza aquí, en este elemental contacto con la áspera arena, el calor aplastante, bajo el refugio del firmamento. El hombre sueña con agua, fresco verdor, fruta apetitosa, fría leche y carne asada. Pierre Dansereau, *Interioridad y medio ambiente*, México, Nueva Imagen, 1981, p. 25.

¡Tan-Tan! ¿Quién es? Es el Diablo,  
ay, una ciega alegría,  
un hambre de consumir,  
el aire que se respira...

José Gorostiza, *Muerte sin fin*.

El análisis de los problemas ambientales y, específicamente, el de los relacionados con la “calidad del aire” en la frontera política que divide a México y a los Estados Unidos, puede hacerse desde diferentes ángulos. En este breve comentario a los ensayos de Ernesto Jáuregui y Howard C. Applegate haré mención a algunos puntos cuya problematización pudiera ser interesante.

1. Cuando hablamos de contaminación del aire en uno y otro lados de la frontera, deberemos referirnos, taxonómicamente hablando, a diferentes tipos de contaminación resultado, como justamente se indica en ambas ponencias, de la desigualdad y heterogeneidad del desarrollo económico y tecnológico que ambos países presentan. Asimismo, la diversidad de los tipos de contaminación es un resultado de las brechas en los niveles de ingreso considerados globalmente y por sectores sociales, en este momento presentes entre México y Estados Unidos. Esta situación

de desigualdad genera agentes contaminantes claramente diferenciados y, también, actitudes y posiciones de la población palmariamente distinguibles frente al fenómeno de la contaminación ambiental.

2. La desigualdad y la heterogeneidad en el desarrollo económico y tecnológico de México y Estados Unidos, es el resultado histórico de una causalidad múltiple que, lejos de tender a una progresiva desaparición, se ha venido profundizando en perjuicio del primero y a favor del segundo.

Esta circunstancia ha dado origen en México a un modelo económico y tecnológico subordinado y dependiente de Estados Unidos con consecuencias aparentemente sin vías de solución: descapitalización crónica, tasas de desempleo *in crescendo*, subempleo endémico, etcétera. En suma, un modelo que un economista mexicano ha dado en llamar de “desarrollo con pobreza”.<sup>1</sup>

Este proceso estructural de subordinación y dependencia, generalizable a otras situaciones nacionales, ha permitido a los países ricos una notable prosperidad al basarse en la explotación barata de los recursos naturales y energéticos, y en la obtención de beneficios de los países pobres. La separación relativa entre países avanzados y países atrasados se ha ampliado y profundizado cada vez más. Un aspecto vistoso y ostensible de este distanciamiento ha sido la brecha tecnológica y empresarial.

El resultado de esta condición estructural de subordinación ha sido tanto la explotación de los recursos naturales y de la mano de obra barata de los países periféricos, como la exportación de plantas, fábricas e industrias altamente contaminantes. De esta manera, los efectos “globales” de la contaminación ambiental permanecen inalterados desde el momento que la fuente de ella ha sido simplemente trasladada y no modificada radicalmente. Desde luego, la acción “local” de contaminación de estas plantas se descarga sobre las áreas deprimidas, subdesarrolladas y periféricas, sumando a la explotación de los recursos materiales y humanos una paulatina degradación del nivel de la calidad ambiental. Este es el caso de gigantescas acerías y petroquímicas establecidas en la última década en México y Brasil, Puerto Rico y Venezuela, Indonesia e Irak.

3. La configuración del Estado-nación en México y en Estados Unidos tiene orígenes y desarrollos distintos. Esta circunstancia histórica condiciona respuestas disímiles a estímulos semejantes. La concepción de la propiedad del aire como *res publicae* en México y, en Estados Unidos, tal y como señala Applegate, como *res communes* es la escenificación de orígenes, tradiciones, expresiones culturales, prejuicios ideo-

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<sup>1</sup> ENRIQUE PADILLA ARAGÓN, *Desarrollo con pobreza*, México, Siglo XXI, 1978.

lógicos y, desde luego, necesidades geopolíticas vistosamente diferentes. En México, el Estado ha tenido un papel importante en la configuración de la sociedad y las clases; mientras que, en Estados Unidos, la sociedad y las clases han contribuido poderosamente en la configuración del Estado. En ambos casos, la relación Estado-Sociedad, obedece a circunstancias histórico-culturales y sociológicas que, de no analizarse bajo la óptica de la pluralidad, de vías y opciones que se presentan para alcanzar el desarrollo histórico-social, se corre el riesgo de caer en percepciones dogmáticas, unilaterales y, por lo mismo, peligrosamente ideológicas del cambio social y sus consecuencias.

4. Los lazos económicos internacionales devienen cada vez más articulados y estrechos. Asimismo, la presencia de organismos de financiamiento y conducción económica, como el Fondo Monetario Internacional y el Banco Mundial, han modificado de tal modo las reglas de juego que, actualmente, ningún gobierno nacional —por pequeño o grande que sea— regula independientemente su propia economía... o evita individualmente la inflación, como reiteradamente hemos podido presenciar en los últimos años. Como ejemplo baste un botón. La euromoneda escapa hoy a la acción reguladora de cada nación considerada aisladamente. Los dirigentes políticos que aseguran "detener la inflación" o "resolver el problema del desempleo" tratan de ocultar el hecho estructural de una creciente internacionalización económica. El Estadonación deviene paulatinamente una entidad problematizable y sujeta a ajustes que probablemente concluirán por modificarlo. Y si las fronteras políticas son económicamente cada vez menos defendibles, ¿cómo protegerlas de las modificaciones ambientales? ¿Cuáles son los límites de la contaminación transfronteriza a través de los cuales definir los alcances del método de la "burbuja"?<sup>2</sup> Si las empresas petroquímicas de la Confederación Helvética vierten sus residuos en el Rhin, la contaminación inundará Alemania Occidental y Holanda hasta depositar sus residuos en el Mar del Norte. La contaminación del aire —que es el tema que hoy nos ocupa—, así como también las modificaciones metereológicas, la destrucción de áreas verdes, los accidentes petroleros en el océano, los estallidos de plantas nucleares o los derrames mortíferos de gases son situaciones todas que rebasan las fronteras nacionales. Estas han devenido chiclosas y mutuamente penetrables. Y, quizá más que nunca, sensiblemente vulnerables. Por lo menos desde la perspectiva de la contaminación ambiental. Y esto, como bien señala el profesor Applegate, hace de por sí jabonoso el problema legal de la responsabilidad territorial; y lo hace aún más, cuando el problema en cuestión se llama frontera aérea o acuática.<sup>3</sup>

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<sup>2</sup> Ensayo de Howard G. Applegate.

<sup>3</sup> *Ibid.*

Y, para no salirme de los límites geográficos que hoy nos ocupan en esta reunión, baste un solo ejemplo: la ASARCO (American Smelting and Refining Company) se localiza, desde 1887, en El Paso, Texas. Como es harto sabido, la ASARCO se encuentra a escasos tres kilómetros del centro de El Paso y a dos de la frontera con México. Produce plomo, zinc, cobre y antimonio. Actualmente produce 110,000 toneladas de cobre y 90,000 de cobre puro. La planta derrama 35 millones de dólares al año en El Paso. Ocupa a mil trabajadores. Según la ASARCO ha invertido más de 40 millones de dólares en equipo anticontaminante y más adelante gastará 70 millones adicionales. Además, según Robert Reid, vocero oficial de la compañía, ésta compró tierras alrededor de la planta y removió cuarenta centímetros de tierra contaminada de la superficie, misma que fue arrojada al Río Bravo con los efectos fácilmente previsibles sobre el Valle de Juárez. De la chimenea de la American Smelting salen toneladas de azufre, plomo y arsénico que, dado que los vientos soplan de norte a sur y viceversa, o bien son muy débiles durante cierto periodo del año,<sup>4</sup> los efectos contaminantes sobre la población de Ciudad Juárez son de preocupar. Además, el dispositivo de tratamiento de residuos sólidos del municipio de El Paso, más dos plantas cementeras, dos refinerías de petróleo y dos grandes fábricas de ladrillo, contribuyen también a la contaminación ambiental de esa ciudad y su vecina Ciudad Juárez. El problema es aparentemente sencillo para el Dr. Donald F. Proctor, de la Escuela de Higiene y Salud Pública de la Johns Hopkins University, el cual recientemente declaró a un periódico de la ciudad de México: "Los actuales índices de dióxido de azufre de El Paso no son peligrosos para la salud..." (de los paseños, podría agregarse). No expresó nada con respecto a los juarenses. En otra aclaración y, refiriéndose a la situación actual de la ASARCO y la conurbación Ciudad Juárez-El Paso-Las Cruces, el Dr. Proctor expresó:

Si se toman en cuenta los verdaderos peligros que para la salud pública significan el fumar cigarrillos y los crecientes niveles de ozono, preocuparse ante el azufre y el plomo que arroja ASARCO es algo así como Nerón tocando el violín mientras ardía Roma...<sup>5</sup>

¿Qué se puede hacer para enfrentar un problema en donde vistosamente una empresa transnacional desafía y rebasa la autoridad de su

<sup>4</sup> Ensayo de Ernesto Jáuregui.

<sup>5</sup> *Excelsior*, 14 de febrero de 1982. En la misma nota, el reportero escribe que Robert Reid indicó que la ASARCO tiene autorizada "0.5 micras por metro cúbico de aire y por hora. ¿No estamos hablando de cosas demasiado grandes, verdad?" Por su parte, Manuel Aguirre, supervisor regional del Texas Air Control Board, admitió que sus computadoras indican que por lo menos seis veces cada mes la ASARCO sobrepasa el límite de contaminación que autoriza la ley estadounidense y señala que la situación se torna cada vez más crítica..."

propio gobierno nacional y cuyas emanaciones letales hacen caso omiso de la noción de frontera política? La ASARCO, en un siglo más lustro de vida, patentiza de manera casi emblemática, en la relación Norte-Sur que personifican México y Estados Unidos, el fenómeno de la "transnacionalización" de la contaminación ambiental.

5. Las orientaciones, objetivos y fines del desarrollo económico no pueden ser analizados como entidades neutrales o valores técnicos sujetos inmediatamente a parámetros cuantificables. Por el contrario, los objetivos del desarrollo tienen un valor social, un significado político y, recientemente, una apreciable valorización ecológica. En este sentido, lo que está en cuestión no es la pregunta ¿quién contamina más? o ¿cuál es el tipo de contaminación presente en un socio-espacio nacional en comparación con otro? Aquí más bien se trataría de plantear la posibilidad de una proceso de desarrollo alternativo e innovador del que participen tanto los integrantes de los países desarrollados como los miembros de las naciones periféricas.

Los contaminantes ambientales en el área Ciudad Juárez-El Paso-Las Cruces tienen procedencia distinta. Mientras que El Paso arroja plomos, azufres y ácidos resultantes de sus fundidoras y refinerías, Ciudad Juárez contribuye con lo suyo arrojando gases derivados de la quema de basura y desechos orgánicos e inorgánicos, así como sustancias nocivas procedentes de las maquiladoras instaladas en su fondo legal. La calidad del desarrollo determina el tipo de contaminación.

Aparte, obviamente, de las medidas legales, los castigos y las multas impuestas a las compañías contaminantes, así como los premios económicos otorgados a las industrias que más rápidamente introduzcan instrumentos anticontaminadores, considero que sería importante hacernos preguntas cuyas respuestas permitan ir en dirección alternativa al actual escenario dominado por los actores que configuran la relación desarrollo-subdesarrollo.

Ante todo es necesario eliminar ciertos presupuestos falsos que han venido dominando la cultura ecológica de los países "en vías de desarrollo", aunque también está presente en los llamados países avanzados. Se trata de la visión evolucionista y positivista orientada a señalar que primero deben resolverse las grandes prioridades del desarrollo y el crecimiento económico, y después buscar una solución a sus consecuencias sociales y ecológicas. Nada tan falso. Tan prioritario como la alimentación y la solución de los problemas energéticos, tan prioritario como la solución a los planteamientos de orden demográfico que formulan nuestras sociedades, tan importante como la eliminación de la miseria y la pobreza, y la cancelación de la problemática del desempleo y el subempleo es, hoy por hoy, ahora como ahora, el problema ecológico, lo que bien podríamos llamar, evocando a Gramsci, "la cuestión ambiental". Evidentemente no se trata de crear un "nuevo problema" para

ocultar los otros. Ni tampoco se trata de erigir una nueva explicación —otra vez ideológica y monocausística— de las desgracias del planeta. Por principio, los problemas no deben ser vistos aisladamente, aunque claro, como diría Bacon, deben resolverse uno a uno. La problemática debe ser vista en su globalidad, en su conjunto. Lo que exige revisar nuestras nociones de desarrollo, crecimiento y de civilización. Para países como el nuestro, la expansión capitalista —tardía, inconexa y desarticulada— ha tenido y tiene un costo social altísimo y no está dicho que resolveremos nuestros problemas más apremiantes. Países como el nuestro han construido un modelo de desarrollo, de orientación euro-norteamericanaizante, de la misma manera que un niño armaría un “rompecabezas” con las piezas de otro. El resultado es un “puzzle” con fragmentos sobrepuertos, ilógicos, desvinculados. Se trata de un producto bizarro.

Reconocer, sin embargo, una realidad tan peculiar como la nuestra no ha sido fácil y no es fácil. Aún más. Es una tarea sumamente compleja y difícil. La Constitución de 1917, en los albores de los regímenes de la Revolución Mexicana, pareció reconocer la realidad múltiple y pluralista de la nación. Años antes, Andrés Molina Enríquez, en un texto clásico de la historiografía y la sociología mexicana,<sup>6</sup> reconocía la existencia de diferentes “niveles de desarrollo” en un país de orígenes y tradiciones tan disímiles como los que integran la nación mexicana. Y aunque a final de cuentas reconocía la superioridad de las orientaciones privatísticas del capitalismo liberal, aceptaba la presencia de formas de propiedad típicas de una economía comunitaria, de origen precolombiano. Este enfrentamiento-convivencia o, si se desea, esta convivencia-enfrentamiento entre diferentes líneas y opciones de desarrollo de las relaciones de propiedad, y de las relaciones de producción ha estado presente en la historia mexicana desde los remotos tiempos de la conquista ibérica y aún no está resuelto del todo. México, desde esta perspectiva, tiene una historia no muy diferente a la de otros grandes países de la “periferia” capitalista: India, China, Irán, Brasil.

6. La pregunta que está en el fondo de todo esto es: ¿el tipo de desarrollo tiene que ser tal cual, *tout court* al que han protagonizado tan exitosamente las metrópolis capitalistas? Es una pregunta que tiene respuestas: se deben buscar vías autónomas o, por lo menos, vías originales que combinen la modernidad con formas tradicionales. Se trata de cambiar a “Gandhi por satélites”, como diría un futurólogo estadounidense. ¿Tiene sentido, nos preguntamos ahora, levantar gigantescos rascacielos en el desierto, como son las grandes acerías y las monumentales petroquímicas cuando el mundo industrial avanzado se encuentra a mitad de camino de un formidable proceso de reindustrializa-

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<sup>6</sup> ANDRÉS MOLINA ENRÍQUEZ, *Los grandes problemas nacionales*, México, Imprenta de A. Carranza e hijos, 1909, 361 pp.

ción donde los protagonistas son la electrónica, las comunicaciones, la genética, la industria aeroespacial y los nuevos combustibles? Precisamente en el momento en que un cierto tipo de industrialización, altamente contaminante entra en desuso, ¿nosotros debemos enarbolarla como bandera, convirtiéndonos una vez más en abogados de causas perdidas, en receptáculos de los desechos del "primer mundo"? Nuestros países parecen hechos de remiendos. No hay homogeneidad en su desarrollo. Y no lo podrá haber sin una revisión profunda de sus parámetros y modelos de crecimiento.

No hace mucho tiempo, durante la década de los setenta, se desarrolló una estrategia de crecimiento basada en la noción de industrias "intermedias": (baja composición orgánica de capital, alta intensidad de mano de obra, etc.) como las industrias rurales, no contaminadoras y con capacidad para generar empleos. El resultado fue, quién lo duda, la conservación de los cielos azules; sin embargo, como diría un conocido gobernante del periodo: no hubo ningún desarrollo.<sup>7</sup> El gran problema es que el papel de la ciencia, la investigación básica y las tecnologías avanzadas quedó relegado. En la práctica se mantenía la condición de atraso relativo sin vías de solución. Daba la impresión de que *Extra chiesa nulla salus*.

La investigación científica ha resuelto problemas propios de los países ricos, pero no de los países pobres. Es por lo tanto necesario fincarse sólidamente en las condiciones históricas propias, haciendo uso de las potencialidades y posibilidades del conocimiento científico y tecnológico avanzados, tratando de inventar —frente al escepticismo— estrategias innovadoras.

7. Me doy cuenta que con esto no habremos resuelto el problema. Apenas lo estamos planteando. Estamos sólo en el inicio, pero con posibilidades estratégicas más reales. Lo utópico no es plantear de esta manera el problema. Lo utópico es creer que por la vía de "más de lo mismo" resolveremos nuestros problemas. El desarrollo no es solamente incrementar el producto nacional bruto. El desarrollo es distribuir más igualitaria y equitativamente el producto de los esfuerzos individuales y colectivos.

En la fase de mayor acumulación de riqueza nunca antes vista por la humanidad concentrada, empero, en un puñado de naciones que se cuentan con los dedos de las manos, la pobreza y la miseria en que se encuentran sumidas más de las tres cuartas partes del género humano, tampoco habían sido tan lacerantes. La crisis económica que estamos viviendo desde los inicios de la década pasada han puesto en evidencia, con gran impacto, esta dramática realidad. Las luchas sociales que

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<sup>7</sup> ALVIN TOFFLER, *The Third Wave*, Nueva York, William Morrow and Co., Inc., 1980, p. 319.

hoy presenciamos en diferentes lugares del mundo y, más cercanamente, en nuestras propias fronteras geográficas y geopolíticas son luchas por el desarrollo, por la repartición de la riqueza, por el aumento social del bienestar, y por la participación en los beneficios de la ciencia y la tecnología modernas. En este contexto, las reivindicaciones no pueden ubicarse en un genérico terciermundismo tardío, desde el momento que son situaciones que nos engloban a todos, desde el momento que nos comprometen a todos en la solución de problemas comunes, difícilmente enmarcables en ámbitos estrechamente nacionales o, peor aún, aldeanamente nacionalistas.

Sin una visión *planetaria* de nuestro compromiso a favor del desarrollo, los conflictos sociales y nacionales internos, generados por su ausencia, nos colocarán en cada momento al borde de enfrentamientos bipolares, con el peligro de arrastrar a la humanidad en su conjunto; sin embargo, también, sin una visión *global* del desarrollo social, carente de una percepción articulada de la relación entre el hombre y la naturaleza y entre la sociedad y la ecología, los riesgos que corremos serán tan desastrosos como los que antes señalamos.

Los académicos estadounidenses y mexicanos aquí reunidos, mismos que en este encuentro tipificamos las percepciones y el patrimonio teórico e ideológico propios del desarrollo y del subdesarrollo expresamos, querámoslo o no, la dramática relación Norte-Sur. Es muy probable que poco podamos hacer para transformarla, pero a lo que jamás deberemos renunciar, lo creo firmemente, es contribuir a señalar las vías más generosas para encontrar los puntos de inflexión que permitan su superación.

Me vienen a la mente, para concluir este comentario, los castigos que, en el Canto XVI de *La divina comedia*, Dante describe para los que tuvieron la desgracia de caer en el Infierno. En el Retorno III del Círculo VIII se encuentran los que, en vida, atentaron contra la naturaleza. Su castigo: yacer inmóviles boca abajo, pegados a la arena ardiente bajo una incesante lluvia de fuego. Pero, también, el florentino nos habla del castigo inclemente que sufren en la Sima VIII del Círculo VIII del Infierno, los que en el mundo aconsejaron fraudulentamente o no supieron aconsejar a tiempo. Su condena era vagar infinitamente con una flama puntiaguda en lugar de la lengua. Estoy seguro que ninguno de nosotros estaría dispuesto a optar por el infierno.

## COMMENTARY

JOSEPH NALVEN

The Canada-United States acid rain war is turning loud, nasty and expensive.

Already a giant United States-based group is running huge newspaper ads telling people not to believe anything they hear about acid rain.

And the ads, paid for by the United States Coalition for Environmental-Energy Balance, brand the attacks Canada has levelled on United States polluters are nothing more than "fashionable rhetoric" by Canadian politicians trying to cover up their own pollution sins and squabbling for power and prosperity.

Canadians, for their part, are about to launch a \$ 100,000 campaign of radio commercials and posters to tell Americans acid rain is ruining the environment and good relations on both sides of the border.<sup>1</sup>

If one considers the "acid rain war" occurring along the United States-Canadian border and then considers the situation along the United States-Mexican border, two general differences can be observed: first, the acid rain or acid deposition problem is greater along the northern border;<sup>2</sup> second, there is no comparable aroused populace across the United States-southern border in Mexico. Despite the chronic, air-pollution transport travelling south from San Diego to Tijuana, and even the more

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<sup>1</sup> Ross HOWARD, "Acid Rain War Turns Dirty", *Toronto Star*, Dec. 30, 1981, p. A-10. See also, Council on Environmental Quality, *Environmental Quality-1979*, Tenth Annual Report, Washington, D. C., 1979, pp. 70-71.

<sup>2</sup> Personal Communications with Environmental Protection Agency staff, Walter Hunt and Lowell Smith. For an overview of United States-Canadian border air pollution problems, see International Joint Commission, "Annual Report-1977", pp. 30-32. For an overview of United States-Mexican border air pollution problems, see Walter Hunt, "United States-Mexico Border Environmental Problems and Ongoing Cooperative Pollution Abatement Programs", Internal Report, EPA, October 15, 1980.

acute air pollution problem associated with the American Smelting and Refining Company affecting Cd. Juárez, the Mexican response has been of an official and technical nature rather than of an organized public one.<sup>3</sup> Indeed, had not United States researchers and government staff taken cognizance of these problems, the Mexican response would have been further delayed.

It is important to note that there is currently a Memo of Intent between the United States and Canada to negotiate a transboundary agreement concerning air pollution problems. The United States State Department was prompted to act as a result of a Congressional resolution inserted into their budget appropriation.<sup>4</sup> At a more general level, the United States decision to enter into these discussions can be attributed in part to Canadian pressure. In the absence of similar Mexican pressure, it is unlikely that United States-Mexico transboundary air pollution problems will be studied in other than scholarly forums. Thus, it is useful to examine the various reasons why there is a reluctant Mexican response to transboundary air pollution problems in order to anticipate the eventual scope of any binational air agreement between the United States and Mexico as well as the timetable for its enactment.

The first explanation points out the institutional lag between these two countries. The United States passed its first federal legislation on air pollution in 1955;<sup>5</sup> Mexico passed its first federal legislation in 1971.<sup>6</sup> Moreover, it was not until the early 1970s that Mexico received extensive technical assistance to train its staff through a United Nations Development Program project.<sup>7</sup> Looked at from the perspective of the transfer of technology from a developed to a less developed country, it would be reasonable to expect a slower and less technologically sophisticated response in the area of air pollution monitoring and aerodynamic

<sup>3</sup> See, for example, the discussion of Tijuana's environmental problems in Dirección General de Ecología Urbana, *Ecoplan del Municipio de Tijuana, Baja California*, SAHOP, 1979, Secciones 3.1 y 3.2. Also, Joseph Nalven, "A Cooperation Paradox and an 'Airy' Tale Along the United States-Mexico Border," *New Scholar* (forthcoming), discusses the low-profile cooperation between San Diego County's Air Pollution Control District and Tijuana's office of the Subsecretaría de Mejoramiento del Ambiente. The Mexican response to the ASARCO case in El Paso is described in C. Richard Bath, "Alternative Cooperative Arrangements for Managing Transboundary Air Resources Along the Border", *Natural Resources Journal*, 18: 1 (January, 1978), 195. Also, personal communication with Howard Applegate.

<sup>4</sup> PL 95-426, October 7, 1978.

<sup>5</sup> PL 84-156, July, 1955.

<sup>6</sup> Ley Federal para Prevenir y Controlar la Contaminación Ambiental. *Diario Oficial*, 23 de marzo de 1971.

<sup>7</sup> HARRY P. KRAMER, "Environmental Education and Training in a Developing Country." (Consultant to Program for the Improvement of the Environment, UNDP), International Conference on Environment Sensing and Assessment, Las Vegas.

modelling of airsheds.<sup>8</sup> The legislative mandates are different for the United States and Mexico: in the United States gaseous monitoring is required, while in Mexico only particulate (smoke and dust) monitoring is required.

The second explanation is a preemptive one, namely, that low-income individuals do not perceive air pollution as a major problem—other, more basic problems (such as employment, access to water, and low prices for food and transportation), receive their attention. Since the income-level is lower in Mexico than in the United States, the perception of and attention to air pollution problems would also be correspondingly lower in Mexico.<sup>9</sup> This argument is one of the central elements of Applegate's paper, which will be discussed in greater detail below.<sup>10</sup>

The third argument is a variation of the preceding one, however, instead of low-income individuals not "perceiving" air pollution as a major problem, they make a conscious choice of dedicating their efforts and resources to higher priority issues. Both United States and Mexican writers make this argument;<sup>11</sup> however, as far as I can tell, none of the Mexican writers give the second explanation. To be sure, it may be that low-income individuals on both sides of the border do not "perceive"<sup>12</sup>

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<sup>8</sup> These comments are restricted to the legislative and technological limitations of the Subsecretaría de Mejoramiento del Ambiente.

<sup>9</sup> Evidently, the relatively higher income level in northern Mexican border cities compared to the rest of Mexico and the relatively lower income level in southern United States border cities compared to the rest of the United States is not sufficiently great enough to overcome the national level differences in income and the perception of air pollution as a problem. Neither Applegate (present paper) nor Bath ("Alternative Cooperative Arrangements", pp. 187-188) press the comparison of regional and binational variation in income levels and the perception of air pollution.

<sup>10</sup> See BATH, "Alternative Cooperative Arrangements", pp. 187-188, for a similar perspective.

<sup>11</sup> *Ibid.*, p. 186; Nalven, "A Cooperative Paradox", pp. 27-28. Even the United States State Department recognizes this choice: "Mexico in general shares our interest in combatting pollution and other threats to the quality of life, as desirable ends in themselves and as a means of keeping conditions in its border zone favorably representative of Mexican society and conducive to tourism. Mexico, however, because of the high cost, can not be expected to try to meet United States air pollution standards in its border area. Mexico tends to play down pollution control priorities when they are seen as impeding economic development." From "United States-Mexican Border Cooperation" (draft), September 6, 1978, p. 6. J. Alberto Villasana Lyon, "Ecology of the Border Region", in Stanley R. Ross, ed., *Views Across the Border: Mexico and the United States*, Albuquerque, University of New Mexico Press, 1978, pp. 333-334, 337. And, for a coordination of development and ecology, or *ecodesarrollo*, see Ivan Restrepo, "Aplicaciones prácticas del ecodesarrollo", in Francisco Szekely, ed., *El Medio Ambiente en México y América Latina*, México, Editorial Nueva Imagen, 1978.

<sup>12</sup> El Paso opinion polls showed that the climate of opinion against air pollution was the same in El Paso as in the rest of the nation. A lower level of

air pollution as a problem, but that their middle-class representatives—be they scholars or government officials—do perceive this problem, but then evaluate it against other problems and decide that it has a low priority. An illustration of the tempering of environmental priorities with, in this case development goals, can be found in an editorial statement in the SMA's *Boletín Informativo*:

La industrialización, que si bien es cierto, es una causa de contaminación y trastornos urbanos, también es verdad —y esto es lo más importante— que ayuda a resolver más problemas de los que ocasiona. Sería erróneo desalentar el crecimiento industrial con base en una política meramente ecologista. Lo fundamental es que su expansión no socave irracionalmente los recursos ni contamine innecesariamente.<sup>13</sup>

This editorial note, which argues that a purely ecological view would handicap industrial growth, was placed alongside an article describing the signing of the United States-Mexico environmental agreement. That article points out that the United States and Mexico have shared problems and that both nations are seriously concerned about human health and community well being. Clearly, there is a message in the juxtaposition of the two pieces: common problems and a mutual concern for human health does not mean that the general strategy for solving environmental problems or the set of tactics employed will be the same for both countries. In Mexico's case, environmental priorities must be weighed against developmental goals. In passing, it is worth noting with some irony that the United States is taking a go-slow attitude in its negotiations with Canada on developing a transboundary air pollution agreement. The United States rationale is beginning to sound similar to Mexico's attempt to balance environmental and developmental goals: a United States official stated "scientists haven't come to agreement on how air pollution works and this administration wants to pay closer attention to what it will cost and is going slower".<sup>14</sup>

At this point, we can turn to Howard Applegate's essay and Ernesto Jáuregui's essay (*Aspectos Meteorológicos de la Contaminación del Aire a lo largo de la Frontera Norte de México*). Taken together, these papers require at least two distinct commentaries—one concerning the pooling of information and its integration into aerodynamic models, the other con-

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agreement was recorded about whether some action should be taken, especially if higher taxes were involved. Cited in Arthur W. Busch, "Environmental Management: A Basis for Equitable Resource Allocation", in Ross, *op. cit.*, p. 356.

<sup>13</sup> Subsecretaría de Mejoramiento del Ambiente, *Boletín Informativo*, II: 7 (junio, 1978), p. 2.

<sup>14</sup> Personal Communication. January 18, 1982.

cerning the kind of regulatory model that would be mutually acceptable to both United States and Mexican environmental authorities.

Applegate has written extensively on the El Paso-Cd. Juárez region, as well as on environmental problems along the entire United States-Mexico border. One of his recent papers, "SYMAPing EPJAZ",<sup>15</sup> illustrates the various ways the region can be mapped with a digitized-grid modelling approach. The specificity of models such as these can guide the collection of data; the models, in turn, can be challenged with different sorts of data. We can imagine fruitful discussions in the interactive analysis of the data called for by Jáuregui in the framework of models being used by Applegate. In terms of San Diego's regional air quality evaluation models (RAQEM), based on a photochemical air pollution model MADCAP (model of advection, diffusion, and chemistry of air pollution),<sup>16</sup> meteorological data on inversions, such as those presented by Jáuregui, are employed. However, these inputs are more important on an hourly-average basis than a daily-average basis if worst-case scenarios are to be developed.<sup>17</sup>

The kind of data suggested by Jáuregui assumes greater importance when considering the possible directions of "predictive" models. For example, an attempt was made by researchers at the University of California, San Diego to predict the regional air quality in the year 1995. The authors found that "emission levels will drop in San Diego while they will rise sharply in Tijuana, making Tijuana a very large contributor to air pollution in the basin".<sup>18</sup> There are several weaknesses with this particular predictive model. First, the authors assume that standards and enforcement will be more rigorous on the United States side of the border. However, since the article was written in 1976—at the height of the environmental movement—there has been a federal effort to weaken automobile emission standards in the United States. Another assumption, less explicit, concerns the degree and nature of San Diego and Tijuana "sharing" air. As far as the process is understood at present,<sup>19</sup> the micro-meteorology of the "shared" air favors San Diego, relative to

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<sup>15</sup> *New Scholar* (Forthcoming Border Issue), Volume 9.

<sup>16</sup> RALPH C. SKLAREW, KHANH T. TRAN, and M. ALAN JONCICH, "Regional Air Quality Evaluation Models", Prepared for the San Diego Air Pollution Control District, September 1978, p. 1.

<sup>17</sup> Personal communication from Hal Brown, APCD Chief Meteorologist, January 15, 1982.

<sup>18</sup> KENT WILSON, et al., "San Diego-Tijuana: Plans Across the Border", *Cry California* (Summer, 1976), p. 32.

<sup>19</sup> San Diego County Air Pollution District and San Diego Comprehensive Planning Organization, "Regional Air Quality Strategies for the San Diego Air Basin", 1976, pp. 19-21. "Revised Air Quality Strategy", September 1978, Draft, pp. 5-13, and San Diego Air Pollution Control District, "Tijuana-San Diego Air Quality Project", September 1977, Section II.

Tijuana, and Los Angeles relative to San Diego (in terms of air transport). It is unclear what the diffusion patterns are or would be in an accurate, binational ambient air quality model.

The collection of the type of data proposed by Jáuregui was considered at the first meeting between SMA staff and San Diego County APCD staff in September, 1977. However, what finally resulted after four years —recognizing that this is yet an ongoing process— was a focus on the collection of particulate data and the establishment of an inspection station for motor vehicles.<sup>20</sup> The choice was for data that conformed with legal requirements (smoke and dust only) and to reach for pragmatic measures with a motor vehicle inspection station. It is unclear how gaseous monitoring would have benefitted Tijuanaans more. Given limited resources, gaseous monitoring is a luxury. This is not to say that the Mexican university system could not, with additional resources, provide the missing pieces of data and analysis.

Some pointed questions must be asked about such transnational, air-pollution modelling. At face value, it is undeniably a meritorious goal —who can deny the quest for knowledge, especially about an environmental pollution process that may have long-term and latent adverse impacts upon the inhabitants of the region, regardless of whether they live on one side of the boundary or the other? However, it must also be recognized that the desire for *high* levels of reliable information is far more generalized in the United States than it is in Mexico. Also, this type of information is less public in Mexico than it is in the United States. The political boundaries to what information is shared is different in both nations. Thus, the quest for building “comparable” transnational data bases may, for the most part, be illusory.

The collection of this data has a purpose, namely, to identify air pollution problems—whether these are direct health impacts, economic impacts from impaired health or from the destruction of plant and marine life, or the corrosion of historic objects. The better the measurement, the more fine-tuned the standards can be. Standards also reflect the degree of desired protection and there are definite costs associated with each degree of protection sought. Applegate suggests that the “bubble” concept would be a cost-effective way of regulating air pollution in binational, twin cities such as San Diego-Tijuana and El Paso-Cd. Juárez.<sup>21</sup> Indeed, the bubble approach is proliferating across the United

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<sup>20</sup> For an examination of the San Diego-Tijuana Joint Air Monitoring Project, incorporating both a Mexican and a United States viewpoint, see Nalven, “A Cooperative Paradox”, pp. 11-21.

<sup>21</sup> There are striking parallels between Applegate’s suggestion that a bubble approach be used for the border’s binational urban centers and the “air market” approach suggested by Harry W. Ayer and Paul G. Hoyt, “Industrial Growth in the United States Border Communities and Associated Water and Air Problems:

States. The EPA has announced \$100 million in savings in bubbles already approved.<sup>22</sup> Under the new regulations, for example, "controlled trades" would be permitted that were formally prohibited: if a printing process could more cheaply reduce its, say, hydrocarbons than a nearby paper coating process, then the latter firm could meet its compliance through the other firm making the necessary reductions. Within the bubble, the overall compliance level would still be reached; it is of little import to the region whether the air quality was maintained by controlling plant X or plant Y.

Applegate argues that placing a bubble over El Paso-Cd. Juárez would be an approach that "ignores political boundaries". From a measurement standpoint, that is true; however, the trading process must ultimately refer back to some standards and if United States and Mexican standards are not identical, political definitions, if not boundaries, would enter into the development of the bubble parameters. In this respect, the Canadians are not enthused about United States bubbles: the United States and Canadian standards are comparable for particulates and sulfates, but not for ozone or hydrocarbons.<sup>23</sup> The problem of standards in air pollution is likely to parallel the problem of standards for water use: if water use standards in El Paso and Cd. Juárez are frozen in terms of present usage, the inhabitants of El Paso would enjoy a permanent advantage of being able to use four times as much water as the inhabitants of Cd. Juárez.<sup>24</sup>

Let us assume, for the moment, that United States and Mexican standards would be comparable in the proposed transnational bubbles. Applegate expects the bubble concept to do double duty—not only as an aerodynamic model and regulatory framework, but also as an economic inducement for Mexico to take an active interest in air pollution control. Remember that Applegate had observed a close correlation between income level and awareness of air pollution as a problem. Given the low-income level in Cd. Juárez, there would be a corresponding absence of interest in air pollution abatement programs. Thus, some other vehicle is needed to induce government officials, if not the wider Mexican public, into a cooperative air pollution control effort.

Applegate states that "if the two governments are seriously interested in dealing with aerial pollution along the border, such an action [the

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An Economic Perspective", *Natural Resources Journal*, 17: 4 (October 1977), 612-613.

<sup>22</sup> "EPA Action Liberalizes Hydrocarbon Bubble Policy", *Journal of the Air Pollution Association* (May 1981), pp. 570, 592.

<sup>23</sup> JOEL FISCHER, International Joint Commission, Washington, D. C. Personal communication, January 18, 1982.

<sup>24</sup> C. RICHARD BATH, "Comentario", *Estudios Fronterizos*, México, ANUIES, 1981, p. 119.

transnational air bubble] should be politically acceptable since it will help the economy of both countries". He uses the example of electronics assembly plants in Cd. Juárez having to install air filters to remove the sulfur dioxide—a pollutant generated on the United States side of the border. Would it not be to the advantage of Mexico to keep these assembly plants (and their jobs) by entering into a bubble agreement with El Paso, thereby reducing the pollutants affecting the assembly plants? Mexico would, in effect, wed an environmental goal to a development goal.

Applegate's argument may be persuasive, but the following objections would have to be considered:

1. What other benefits would accrue to Mexico or would Mexico simply be entering a United States bubble to protect one United States-owned industry from another?
2. What kind of costs might Mexico have to bear if they entered into the bubble concept? Would open trash burning have to be curtailed, roads paved, and older cars better maintained or more rapidly replaced with new cars? These air pollution control tactics may ultimately be what Mexican officials require; the question is whether there is sufficient inducement to advance the timetable.
3. How would the least-cost distribution practice affect the economy of the Mexican border cities? Could, for example, a United States firm in dire need of emission reduction simply buy the permit of a Mexican firm and close it up?
4. Would pressure mount to make the "bubble" an "environmental" rather than simply an "air" bubble? A broader conceptualization would enjoin trade-offs, e. g., between air and water issues.

Applegate goes to considerable lengths to provide a legal (ownership of air) and innovative regulatory (bubble) framework for transnational air pollution cooperation. Once again, we might profit by considering the United States-Canadian border. The activities of the International Joint Commission in the area of air pollution suggest that the only basis required for cooperation is common-sense about not polluting one's neighbor. Article IX of the IJC permits this body to study almost any issue by a "reference" procedure.<sup>25</sup> Since 1928, four air pollution issues were referenced (out of 47 through 1977) in what essentially is a boundary and water commission.<sup>26</sup> Perhaps of most interest to regional air pollution control strategies is the way in which the IJC provides

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<sup>25</sup> Treaty Between the United States and Great Britain Relating to Boundary Waters and Questions Arising Between the United States and Canada, January 11, 1909.

<sup>26</sup> International Joint Commission, "Annual Report-1977", pp. 40-45.

supportive activities to the International Ontario-Michigan Air Pollution Board.<sup>27</sup>

Although the International Boundary and Water Commission for the United States-Mexico border is constituted differently than the IJC and has no equivalent reference procedure, it, too, could be modified to function as an overseer of air pollution problems directly, or in support of federal, state, and local agencies operating within the Memo of Understanding between the EPA and the SMA.<sup>28</sup> However, what could be will not be—until the problems become so severe that air problems surpass border water problems or until as Applegate observes the income level rises with a concomitant “dissatisfaction with air pollution... When enough people reach this point, they will demand that air pollution be curtailed. Thus actual air pollution must increase along with increasing affluence before the public will demand less potential air pollution and thus have cleaner air in the future”.

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<sup>27</sup> International Joint Commission, “First Annual Report on Ontario-Michigan Air Pollution”, 1976, pp. 3-4.

<sup>28</sup> See C. RICHARD BATH for a comparison of the IJC and IBWC, “Alternative Cooperative Strategies”, pp. 184-189. Also, Joel Fischer, Jim Chandler, and Verlee Prybylosky, “International Aspects of the Clean Water Act”, *Proceedings of the Academy of Natural Sciences*, Philadelphia, February 27, 1982.



## MODERATOR'S SYNTHESIS

C. RICHARD BATH

Air pollution has only recently been regarded as a proper focus of concern for public officials along the United States-Mexico border. Several explanations may account for the late arrival of contamination of the air on the public agendas of both countries. First, air pollution is a relatively new federal governmental concern. In the United States the first major legislation with any real enforcement powers was the Clean Air Amendments of 1970. In Mexico the first federal legislation covering air pollution was passed a year later in 1971. Federal legislation is an absolute essential for successful efforts to abate air pollution along the border because of the presence of the international boundary and the requirement of national participation for resolving boundary questions. On the other hand, border air quality suffers from a lack of clear governmental responsibility and attention at the federal level. Washington and Mexico City are far away and, for one reason or another, neither appears able to adequately cope with border problems within its own policy framework. On the United States side the complex federal arrangement, which leaves large issue areas to state and local governmental entities, comes into play. In Mexico the border has not fared much better, although the complexities of federalism are not quite as important. Aside from the question of the proper role of the border region in the policy framework of both countries, there is also the general lack of awareness of the size of the population in the borderlands and its attendant problems. Perhaps the rapid increase in population, as well as increasing economic importance on both sides of the border, caught federal policy makers unaware of the magnitude of environmental problems in the borderlands. One also wonders of the stereotype of the sleepy, economically depressed, and backward border may not have effected the attitudes of federal officials. Another reason for the lack of attention paid to air pollution is that questions involving water —the most precious of commodities in a semi-arid region— tend to predominate. Water has often, as in the case of the Río Grande or Río Bravo and in the Colorado River, served as a boundary line between the two countries. Water is critical in most of the borderlands region and it is also something

which can be seen, measured, divided, and allocated. Although there have been severe problems with water between the two countries, as another section of this volume illustrates, water is certainly easier to deal with by governmental agencies than the more amorphous and indivisible matter of air. In point of fact, air quality does not fit the legal or regulatory structures of either Mexico or the United States very well.

Yet, air is quite as important as water, and air quality needs to be regulated because the problem of air pollution is acute all along the Mexico-United States border. While major attention tends to focus on the metropolitan regions of El Paso-Ciudad Juárez or San Diego-Tijuana, serious air pollution problems can also be found in rural areas as well as smaller cities such as the *ambos* Nogales region. The two major urban areas receive the greatest attention because the problems have been more precisely defined by scientists and engineers, not to mention that pollution is worse. In fact El Paso-Ciudad Juárez is one of the most polluted air sheds on the continent. We have accumulated an increasing amount of data about air pollution along the border to aid governmental officials in their efforts to improve air quality.

During the 1970's air pollution along the border became of increasing importance to both nongovernmental and governmental groups. The conference on which this volume is based is but one of many which have been devoted entirely or, more likely, partially to problems of air pollution in the border lands. The First Bi-National Conference on Air Pollution Along the United States-Mexico Border met in El Paso in September, 1973, with representatives from government agencies, universities and private groups. Suffice to say that the two federal agencies responsible for air quality, the Environmental Protection Agency and the Subsecretaría de Mejoramiento del Ambiente, were both surprised to find a number of people concerned with the problem of air pollution. Since that meeting a host of conferences and other meetings have included air quality as an issue and a large group of university professors, technicians, interest groups, and citizens have evidenced interest in the governmental response to the problem. The issue has also reached the policy agenda between the two countries. Officials from the EPA and the SMA have met repeatedly to discuss technical and policy issues involving air pollution. In the 1978 Memorandum of Understanding signed by the two Presidents, Jimmy Carter and José López Portillo, air pollution was included with other environmental issues as a proper subject for mutual concern and resolution. Although so far little federal action has resulted from this agreement, it is important to note that it officially exists as an item of joint concern. At the recent meeting of Border Governors in El Paso in September, 1981, air pollution was included in the list of environmental issues brought before the governors

from both sides of the border. In an unprecedented action, Tijuana and San Diego have reached agreement in April, 1981, for the exchange of technical data, training, and equipment. Such an agreement between the two cities is unique since it does not include participation by the federal governments and may, in fact, provide a useful model for other twin cities to follow in attacking the problem of air pollution. By 1982, then, air pollution and its successful abatement were entrenched in the governmental agencies on both sides of the United States-Mexico border.

All of these efforts have international or binational implications. Aside from bilateral agreements, efforts, usually under the auspices of the Pan American Health Organization, have also been made for mutual initiatives to handle air pollution. Most notably is the air sampling programs in El Paso-Ciudad Juárez and San Diego-Tijuana, both started with the support and aid of PAHO. The United States-Mexico Border Public Health Association has also played an important role including air pollution items in its annual meeting as well as in the Environmental Health Committees established in several twin border cities. These meetings help involve local officials in their mutual problems.

As a question from the audience makes abundantly clear, the international legal questions involved in air pollution are incredibly complex. There are no clear standards under international law to help resolve a mutual problem such as air pollution. Precedents which are most often invoked are the Trail Smelter Arbitration between the United States and Canada and Principle 21 of the United Nations Declaration of the Human Environment. The Trail Smelter Arbitration stemmed from air pollution crossing the international boundary from Canada into the United States and the arbitration commission eventually awarded damages to farmers in the state of Washington. Principle 21 of the Stockholm declaration asserts that states have "...the responsibility to ensure that activities within their jurisdiction or control do not cause damage to the environment of other States..." Neither of these are regarded as strong precedents for joint action on environmental issues. For example, the first half of Principle 21 gives each state the sovereign right to exploit its own resources and clearly conflicts with the second part of inflicting environmental damage. In both the case of the ASARCO smelter located in El Paso and the blowout of Ixtoc I in the Gulf of Mexico the question of liability is not clear and would require international adjudication. The parallel between ASARCO and the possibility of lead poisoning of children with that of the Trail Smelter and damages inflicted on cattle is most obvious, but, at this juncture, an approach to air pollution based on international law does not appear to offer much relief to those suffering from the problem in the borderlands. Certainly a treaty between the two countries would greatly help, but the likelihood of such a treaty having meaningful enforcement provisions is very low. A treaty

would be at the lowest possible level of agreement and, while it could provide a symbol for binational concern, it would not help alleviate air pollution. For the moment the current activities of local, state, and federal officials, limited though they may be, appear to offer the best possibilities for air pollution abatement.

So far regulatory efforts on both sides of the border have been minimal, and the primary reason is both a lack of public concern with air pollution, as well as a general lack of commitment by public officials to abatement. In turn, the lack of will power by governmental officials reflects the economic situation of the borderlands. As Dr. Applegate's essay makes clear, the level of economic development may be the major handicap to mutual solution of air pollution problems. In fact, it is the level of economic development which makes it so difficult to control air pollution along the border. Dr. Jáuregui's essay is a technical one that attempts to establish a base for acquiring required data — data that is essential if successful abatement programs are to be developed. We do not have very good data and the problem is particularly acute on the Mexican side because of a lack of trained personnel and the necessary equipment to measure air pollutants. However, the United States also lacks certain of the required data. Without determination of the sources, types and levels of pollutants, how effective can possible enforcement programs be? The answer is simply that they cannot be. Dr. Jáuregui's paper represents a sophisticated approach towards the accumulation of such data, but Mexico will have to devote far more resources towards air pollution control than it has up to this moment. In the opinion of many, Mexico is a developing country and cannot afford to devote such resources to environmental management until it is economically more developed.

Dr. Applegate has written a far more ambitious essay; in fact, he has written a revolutionary paper in the sense that he is asking for a totally new approach to the problem by both governments. One should point out that Dr. Applegate has pursued the goal over the last fifteen years of attempting to improve the air quality of the borderlands region. He is one of those unique individuals who, through total dedication to his work, has achieved a pinnacle rarely reached by individuals in international relations: he has brought the issue of air pollution to the attention of both governments and kept it there by his own diligence and persistence. While he is the leading scientist concerned with border environmental issues, his paper recognizes that technical data alone does not suffice; the will to change is also necessary. He asks for a total change in the legal and regulatory structures within which air pollution control efforts are made. He clearly recognizes the importance of the differences in economic development, not to mention legal concepts, between the two countries. Perhaps because he is so close to the problem

and has seen the evident lack of results of regulatory efforts by existing governmental agencies and officials, he offers a radical new approach to pollution control.

For those who have been actively involved in environmental issues in the border region, the ineffectual and minimal regulatory response of the governmental agencies involved is discouraging. However, two recent developments may portend a happier future for environmental management along the United States-Mexico border. The lack of will on the part of public officials probably reflects a lack of concern on the part of the public as a whole towards environmental problems. Partly in the border region this reflects the level of poverty found on both sides of the border. The poor do not often regard environmental management with the highest of priorities. As a result the political will to action is lacking in governmental officials because they view the public as uninterested. Things may be changing. In El Paso, which has displayed no noticeable public interest in air pollution for the last ten years, a recent hearing for extension of a variance for sulfur oxide emissions resulted in the attendance of about 120 citizens, many of them prominent attorneys and other knowledgeable citizens. A petition rapidly circulated resulted in 10,000 signatures opposed to the granting of the variance. Such actions probably shocked elected officials and, if they continue, may lead to far more interest on the part of governmental representatives to control air pollution.

A second event is especially important for Mexico where the critical problem has been the role of environmental management in the process of economic development. In general, Mexico has followed the Third World position that economic growth should take precedence over concern for the environment; indeed, pollution is regarded as the price to pay for industrialization. Economists from the developing region have supported this view in their drive for economic growth. However, in September, 1980, a group of economists associated with the Economic Commission for Latin America dramatically changed their view and announced that they had been in error, that environmental damage should, indeed, be a serious consideration in the process of economic development. These economists included Osvaldo Sunkel, Aníbal Pinto, Fernando Cardoso, and, the dean of Latin American economists, Raúl Prebisch. Such a major change in focus by the leading economic thinkers in Latin America may eventually provide the intellectual leadership for countries of the Third World, including Mexico, to take a more serious look at environmental damage and its impact on the economic development process. Such a change of attitude would also provide a more congenial atmosphere for joint action between the United States and Mexico to insure more successful environmental control and management for the borderlands.

## RESUMEN EN ESPAÑOL

Las explicaciones que pueden darse al hecho de que apenas recientemente los funcionarios públicos de México y Estados Unidos hayan atendido el problema de la contaminación del aire son varias. Una de ellas es la ausencia de legislación federal al respecto hasta 1970 en Estados Unidos y hasta 1971 en México. La legislación de tal alcance es esencial para combatir la contaminación en la frontera, pues las leyes estatales no bastan para resolver situaciones que se dan en límites internacionales.

Otra razón del desinterés en la contaminación del aire es que han predominado los asuntos relativos al agua, el máspreciado de los bienes en una región semiárida. Además, aunque han existido problemas severos debidos al agua entre los dos países, el agua es más fácil de ver, medir, dividir y evaluar que el aire amorfo e indivisible. Es un hecho que la calidad del aire no encaja muy bien en las estructuras jurídicas de Estados Unidos y México. Otra explicación alude a las dificultades económicas que enfrentan los países en desarrollo.

El convenio entre San Diego y Tijuana para intercambiar información técnica, personal entrenado y equipo es un modelo a seguir por otras ciudades colindantes en la frontera. También destacan los programas auspiciados por la Organización Panamericana de la Salud para hacer evaluaciones de la calidad del aire en varias ciudades fronterizas. Sin embargo, es evidente que no hay normas internacionales precisas que permitan resolver problemas como el de la contaminación del aire. Al respecto, los precedentes invocados másfrecuentemente son el Arbitraje de la (Fundidora) Trail Smelter entre Canadá y Estados Unidos, y el Principio 21 de la Declaración de la Conferencia de las Naciones Unidas sobre el Medio Humano.

De la ponencia del Dr. Jáuregui destaca su intento de establecer una base técnica para obtener la información que es esencial si se desea desarrollar programas adecuados para abatir la contaminación del aire.

El Dr. Applegate va más allá y en su ensayo reconoce que la información sobre los aspectos técnicos no es suficiente y que la decisión de cambiar es también necesaria. Además señala la importancia que tiene la diferencia en el desarrollo económico de ambos países. Los pobres no

ven el manejo del medio ambiente como un asunto de la más alta prioridad, por lo que ante ciudadanos desinteresados tendremos funcionarios públicos indiferentes.

Pese a todo, la situación tiende a mejorar, pues cada vez hay más reacciones positivas de grupos de ciudadanos frente a los problemas de la contaminación del aire y, además, se conoce la declaración de varios intelectuales cercanos a la Comisión Económica para América Latina (CELA) que difiere de la posición tradicional de los países del tercer mundo, entre ellos México, en el sentido de que el crecimiento económico debe tener prioridad sobre los problemas del ambiente, por lo que la contaminación ha de verse como el precio del inicio de la industrialización. Tal cambio de actitud podría crear una atmósfera más adecuada para las tareas conjuntas entre Estados Unidos y México, que buscan un control más efectivo del medio ambiente en la frontera.



*WATER*

IV

AGUA



# SHARED WATER RESOURCES IN THE UNITED STATES-MEXICO BORDER REGION: PAST SUCCESSES AND FUTURE PROBLEMS

ALBERT E. UTTON

In the border region we are faced with three major factors: increasing population, expanding economic development, and finite water resources, all in the context of an international frontier. The population is projected to double in the border region in the next twenty years, and demand for the limited water resources will surely increase. Therefore, it is an appropriate juncture to take stock of our water resources and management of them and to make recommendations for the future.<sup>1</sup>

## GROUNDWATER QUANTITY AND QUALITY

The heaviest groundwater users in the United States are the states which are contiguous to Mexico,<sup>2</sup> and yet, paradoxically, the law and institutions of these border states are woefully inadequate to control the exploitation of their groundwater resources.<sup>3</sup> In addition, international competence over aquifers divided by the frontier is largely undefined; it is fair to say that the legal and institutional situation is chaotic.<sup>4</sup> Still largely true is Professor Clark's statement that none of the border states

has adequate legislation or regulations for the protection and management of diminishing supplies within the state and along

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<sup>1</sup> See, United States-Mexico Study Group, Summary Report: Anticipating Transboundary Resource Needs and Issues in United States-Mexico Border Region to the Year 2000, South Padre Island, Apr. 23-24, 1981.

<sup>2</sup> CLARK, "Institutional Alternatives for Managing Groundwater Resources", *Natural Resources Journal*, 18 (1978), 158.

<sup>3</sup> BURMAN & CORNISH, "Needed: A Groundwater Treaty Between the United States and Mexico", *Natural Resources Journal*, 15 (1975), 385, 388-391.

<sup>4</sup> It has to be noted, however, that the IBWC has done a remarkable job of resolving groundwater problems to date with a minimum of treaty mandate or international practice as precedent.

the border areas. New Mexico has the only public control system, but regulations under it do not contemplate joint controls in the area of the border. Arizona and Texas have virtually no controls except voluntary ones, and the California law is beholden to similar rules of capture which do little to discourage excessive pumping and waste.<sup>5</sup>

Both Arizona and California have made or are making efforts to reform their groundwater law, but the legal authority to manage groundwaters on the United States side is inadequate. In contrast to the legal situation in the United States, Mexico does have legal authority to control groundwater withdrawals. The national government, through the Secretariat of Water Resources, can regulate extraction, and the Secretary, on his own initiative, can establish prohibited groundwater zones if existing developments or the aquifer is in danger of being adversely affected,<sup>6</sup> or if it is otherwise in the public interest. At the international level, the IBWC has been authorized only to exchange information and to control withdrawals in one area of the border near Yuma under Minute 242.

Coincident with the near legal vacuum, significant population and economic growth is projected on both sides of the border, making it reasonable to anticipate that there will be increasing pumping and accelerating demand placed on groundwater resources bisected by the international boundary between the two countries.<sup>7</sup> This increased demand, combined with a striking absence of institutions for either resolving disputes or managing the resource, raises the specter of dispute between the two countries.<sup>8</sup>

Perhaps the best example of potential conflict between the two countries due to the increased competition for transboundary groundwaters is that of the cities of El Paso and Juárez.<sup>9</sup> The metropolitan area of Ciudad Juárez, Chihuahua, and El Paso, Texas, has over one million inhabitants. Both cities depend largely on shared groundwater reservoirs for their municipal water supplies. Studies indicate that both sides now are pumping at a rate faster than the groundwater reservoir is being recharged. Day reports that

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<sup>5</sup> CLARK, *loc. cit.*, 155-156.

<sup>6</sup> TECLAFF, "Abstraction and Use of Water: A Comparison of Legal Regimes", U. N. Doc ST/ECH/152 (1972), 62.

<sup>7</sup> See, ALBA, "Condiciones y Políticas Económicas en la Frontera Norte de México", *Natural Resources Journal*, 17 (1977), 571; Bradley & DeCook, "Ground Water Occurrence and Utilization in the Arizona-Sonora Border Regions", *Natural Resources Journal*, 18 (1978), 29; Day, "International Aquifer Management: The Hueco Bolsón on the Río Grande", *Natural Resources Journal*, 18 (1978), 163.

<sup>8</sup> See, DAY, *loc. cit.*

<sup>9</sup> BRADLEY & DECOOK, *loc. cit.*, 36.

[b]etween 1903 and 1976, water levels fell as much as 73 feet in the center of El Paso and 85 feet in Ciudad Juárez. Based on a digital model study, Meyer predicts extensive Hueco Bolsón drawdown by 1991 concentrated in the center of Juárez and northeast El Paso. Annual recharge to bolson aquifers may be as little as 5 percent of the annual withdrawal.<sup>10</sup>

He suggests that “[i]ndigenous Río Grande groundwater supplies are already overdeveloped and serious doubts exist that there is sufficient water to support expected growth in total water demand”.<sup>11</sup> He goes on to conclude:

Although the imbalance in expanding water use and long term availability does not pose an immediate problem, over the long term water supplies for the international community, which is presently heavily dependent on the Hueco Bolsón, will probably become more distant, more expensive, more scarce, and possibly of lower quality. Scientific evidence at hand does not permit an accurate estimate of the cost.<sup>12</sup>

Dr. Neal Armstrong of the University of Texas adds a water quality dimension:

Groundwater from the Hueco Bolsón deposits is being mined in El Paso County and the Juárez area, and depletions in storage are causing saline water encroachment from aquifers and degradation of groundwater quality. The amounts of fresh to slightly saline water that can be removed under “safe yield” conditions have not as yet been determined. Induced recharge or leakage from the alluvium is slowly degrading the quality of groundwater pumped from the Bolson deposits. Water quality degradation will also occur due to lateral and vertical encroachment of saline water from adjacent saline water sands in the Bolsón deposits as the fresh to slightly saline water in storage is depleted.<sup>13</sup>

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<sup>10</sup> DAY, *loc. cit.*, 168.

<sup>11</sup> *Ibid.*, 169.

<sup>12</sup> *Ibid.*, 177-178.

<sup>13</sup> ARMSTRONG, “Anticipating Transboundary Water Needs and Issues in the United States-Mexico Border Region”, paper given at South Padre Island, Apr. 23-24, 1981, 3.

## RECOMMENDATIONS FOR THE FUTURE

Given the dramatic population increases projected for the border area, what suggestions can we make to protect economic development? What suggestions can we make to improve the security of water supply and thereby the investment of groundwater users in the border area? How can we ensure that each nation will receive a fair share of the transboundary resources in the border region, adequately protected so as to avert unnecessary and damaging conflict between the two neighbors? How can we avoid what Professor Clark calls "education by disaster"?<sup>14</sup>

The following proposals are made with a view to improving the allocation and management of transboundary groundwaters in general and the United States-Mexican border region in particular:<sup>15</sup>

1. There must be conjunctive management of surface and groundwater in areas where supplies are interrelated. In the management of international groundwaters it is essential to recognize the interrelationships between surface and groundwaters, which are frequently interconnected. Contrary to hydrologic reality, the law frequently has made distinctions which separate surface water from underground waters. The distinctions have failed to recognize interrelationships between surface and underground waters.
2. Legal rights should take into account the hydrologic fact that water is a fugitive resource and that therefore the legal rights are to the control and use of the water, not the ownership of the water.
3. Decisions such as the spacing of wells and the rate of drawdown need to be carried out according to a reasoned development scheme.
4. Hydrologic information needs to be developed carefully in order to plan for the use of the supply over a calculated period, to determine safe yield and to prevent salt water intrusion.
  - a) There should be a system of measurement of withdrawals from wells.
  - b) Records must be kept of withdrawals over a period of time.
5. Controls must be placed on drilling in those areas where present and future uses may be endangered.

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<sup>14</sup> CLARK, *loc. cit.*, 157.

<sup>15</sup> *Ibid.*, 158; See also, Mumme, "The United States-Mexican Conflict over Transboundary Groundwaters: Some Institutional and Political Considerations", *Case Western Journal of International Law*, 12 (1981), 505.

6. Allocation procedures, including permits, must be flexible in order to anticipate and minimize conflicts and shortages and to facilitate transfers to other uses.
7. The planning process should be flexible enough to allow for planned depletion over a calculated period by certain uses such as irrigation or municipal water supply. The planned depletion or mining of water can be justified in the same way as the mining of nonrenewable mineral resources such as oil, coal, or copper, but the decision to mine has to be made after thorough investigation, and the development must be orderly and rational. This is particularly so where the groundwater resource is divided by an international boundary, in view of the fact that depletion of the resource and the consequent damage to the other country cannot be easily corrected by natural recharge.
8. The management effort must include and be related to all water quality matters.
9. The IBWC should be given jurisdiction over groundwaters intersected by the international boundary and authority to apportion the waters of the aquifer and close the area to withdrawals beyond the allowable as determined by the physical criteria of the aquifer. Allocation of transboundary water resources whereby each nation is allocated its equitable share of the groundwaters is more likely than a comprehensive management approach due to the sovereign sensitivities of nation states.<sup>16</sup>
10. The actual allocation, administration, and enforcement of water rights and water quality standards within each nation's portion of water in a designated international groundwater area should be within the national jurisdiction of that nation and its appropriate political subdivisions.
11. In addition, there should be a generally overriding, supervisory enforcement power lodged in the Commission to ensure that each nation lives within the total water budget allocated to it by the basic apportionment, and that each nation abides by its obligations for protecting the water quality of the aquifer.
12. In the event of prolonged drought which in the judgment of the Commission significantly affects recharge, the Commission should be authorized to reduce the total allowable withdrawal from the designated international groundwater area for so long as the Commission deems necessary, and each nation's withdrawal shall be accordingly reduced proportionately.

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<sup>16</sup> These suggestions have been made repeatedly elsewhere. See, e. g., Utton, "International Groundwater Management: The Case of the United States-Mexican Frontier", *Nebraska Law Review*, 57 (1978), 633, 640.

## WATER QUANTITY

The quantity of water apportioned to each country from the Río Grande and Colorado Rivers has been established by the Treaties of 1906<sup>17</sup> and 1944.<sup>18</sup> The 1906 Treaty guarantees 60,000 acre-feet per year to Mexico from the Elephant Butte Dam in the upper Río Grande.<sup>19</sup> The 1944 Treaty<sup>20</sup> provides Mexico with 1,500,00 acre-feet per year from the Colorado and apportions the waters of the Río Grande below Fort Quitman about equally between the two countries.

Some twelve hundred miles of the boundary between Mexico and the United States is formed by the Río Grande. All but one hundred miles of this river boundary is below Fort Quitman and is thus in the lower Río Grande basin.<sup>21</sup> Drainage from Mexico accounts for 70 percent of the water flowing in the lower Río Grande, and that from the United States contributes approximately 30 percent.<sup>22</sup>

At times the apportionment of the lower Río Grande has been questioned, and Dr. Oyarzabal has recommended that it be reexamined in view of the fact that Mexican tributaries contribute over two-thirds of the supply, yet the flow of the Río Grande is divided nearly equally.<sup>23</sup>

However, the apportionment of the lower Río Grande was part of the trade-off for the agreed division of the Colorado, and the thought or reopening the apportionment does not generate much enthusiasm. In addition, there are a number of smaller rivers shared by the two countries which have not been apportioned. These include the San Pedro, which flows north from Sonora to southeastern Arizona; the Santa Cruz, which rises in Arizona, loops south into Sonora, and then flows back into Arizona; and the New River, which flows north from Mexicali into California.

In general, it is fair to say that the apportionment of the major rivers, and their administration, shared by the two nations is a model

<sup>17</sup> Río Grande Irrigation Convention with Mexico, May 21, 1906, 34 Stat. 2953, T. S. N° 455.

<sup>18</sup> Utilization of the Waters of the Colorado and Tijuana Rivers and of the Río Grande, Feb. 3, 1944, United States-Mexico, Arts. 10, 15, 59 Stat. 1219, T. S. N° 994 (effective Nov. 8, 1945) [hereinafter cited as 1944 Treaty].

<sup>19</sup> Río Grande Irrigation Convention, United States-Mexico, Art. 1, May 21, 1906, 34 Stat. 2593, T. S. N° 455.

<sup>20</sup> 1944 Treaty, Arts. 10, 15.

<sup>21</sup> *Ibid.*, Art. 11.

<sup>22</sup> Hearings before Committee on Foreign Relations, United States Senate, 79th Congress, 1st Sess. (1945); See also, Tipton, "Engineering Memorandum on Treaty with Mexico for the Utilization of the Waters of Certain Rivers", in Six States Committee (1943), 74.

<sup>23</sup> OYARBÁZAL, "La Calidad de las Aguas del Río Bravo", paper given at South Padre Island, Apr. 23-24, 1981.

of international cooperation. However, there is one major problem relating to quantity which has not been adequately resolved, and which has the potential for seriously affecting the relations of the two countries. That is the question of how to share shortages—how to share the available supply during times of drought.

The Treaty provides that in the event of “extraordinary drought or serious accident” in the United States, minimum amounts to be delivered by the United States may be reduced in the same proportion as are consumptive uses in the United States.<sup>24</sup> This “extraordinary drought” provision is the major remaining water quantity issue.

The generality of the drought language could lead to substantial problems in times of water shortage. César Sepúlveda observes that these questions “could seriously affect the relations between the two countries”, and goes on to illustrate the concern of Mexico:

The Treaty of 1944 failed to specify whether the drought could occur in the total region served by a river system or only in a portion of it, and also did not define the intensity nor duration of the drought. Further, no precise measurement is provided. Such imprecisions give rise to many interesting hypothetical questions. For example, if severe drought conditions do indeed exist in the United States during one year, the reduction in consumption would not be immediately calculable, and until such calculations would be made, would Mexico not be entitled to receive her full allotment of water?

A respected American commentator adds: “It takes little imagination... to foresee conflict if Mexico’s deliveries are ever cut” under the “extraordinary drought” provision.<sup>25</sup>

#### SUMMARY OF WATER APPORTIONMENT AND REMAINING PROBLEMS

1. The major surface flows have been amicably apportioned;
2. the waters of the major drainage basins are presently completely committed;
3. in view of the full appropriation, as population and economic development increase along the border and in the major drainage basins of the Colorado and Río Grande, greater conservation measures will have to be taken to stretch the available supply.

<sup>24</sup> 1944 Treaty Art. 10.

<sup>25</sup> MEYERS & NOBLE, “The Colorado Treaty with Mexico”, *Stanford Law Review*, 19 (1967), 415.

- and more water-intensive agricultural uses will have to be retired in favor of municipal and industrial uses; and
4. the question of sharing of shortages is unresolved and hangs as something of a sword of Damocles over United States-Mexico relations in view of the fact that the margin of error is being reduced by increasing populations and economic development.

## WATER QUALITY

### A. *The Colorado*

The water of the Colorado is the lifeblood of the thirsty southwestern United States and the Mexicali Valley of northwestern Mexico. It presently meets the needs of 15.000,000 people in supplying water for their cities and irrigating the agriculture, mining and industrial enterprises within the basin, not to mention the recreational, fish, and wildlife uses of the river.

In this context, water quality has been a prime irritant to the peaceful relations of the two countries, and is one that both will have to watch closely. They have struggled with this problem through a series of interim agreements which culminated in Minute 242, a binational agreement to constitute a "permanent" solution to the salinity problem. Minute 242 was signed on August 30, 1973, by Ambassadors Herrera of Mexico and Friedkin of the United States. Its most important provision is that the salinity of the water at the Morelos Dam shall be no more than 115 parts per million plus or minus 30 parts per million above that of the salinity at the Imperial Dam. This, in fact, means that the farmers in the Mexicali Valley of Mexico will be irrigating with water which is no more than 115 parts per million plus or minus 30 parts per million higher than the salinity of the water which their American neighbors in the Imperial Valley across the international boundary receive from the Imperial Dam.

Nonetheless, there still is potential for water quality questions to arise between the two countries. Specifically, there is a range of potential water quality impacts from energy development in the Colorado River Basin, and, as Professor Bishop states, "the water quality problem of most concern to both the United States and Mexico is salinity".<sup>26</sup>

The Colorado River Basin is one of the richest storehouses of energy resources in the United States. Within the four states of New Mexico, Arizona, Colorado, and Utah, conservative estimates indicate that there are more than 23.5 billion tons of recoverable coal reserves, of which

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<sup>26</sup> See, BROWNELL & EATON, "The Colorado River Salinity Problem with México", *American Journal of International Law*, 69 (1975), 255.

more than half are of the low sulphur variety which is in demand for electrical generation. In addition, these four states contain nearly 90 percent of the uranium reserves of the United States, and virtually all the domestic oil shale reserves are located in Colorado, Wyoming, and Utah.<sup>27</sup>

Various studies have attempted to assess the change in Colorado River salinity as a consequence of this development, and it generally is agreed that increased energy development will lead to increased demand and that salt concentrations in the river therefore are likely to rise. This increase can be expected because of reduced amounts of water for dilution.<sup>28</sup> Various strategies have been devised to contain salt releases into the Colorado, and under Minute 242 the desalting plant at Yuma has considerable capacity for taking salt from Colorado River waters; however, increased consumption has the potential for raising saline levels. Careful vigilance will be required, and new technologies such as less water-consumptive cooling towers in electrical power plants and drip and sprinkler irrigation will have to be increasingly used to stretch available supplies. Also, water will have to be transferred from water consumptive uses such as agriculture to industrial and municipal uses.

#### **PRESENT STATUS AND SUGGESTIONS FOR THE FUTURE**

1. Present efforts being undertaken under Minute 242 and the Salinity Control Act have the promise of keeping salinity levels within acceptable limits.
2. The conservation of existing supplies will have to be intensified at all levels, including the use of new technologies in agriculture and energy production activities.
3. Many water intensive uses such as farming will have to be reduced to accommodate new populations and economic growth. This is already happening at a substantial rate.
4. Finally, this growth will require constant review and vigilance so as to anticipate and avoid unacceptable increases in salinity as well as other contaminants.

#### **B. *The Río Grande***

At the present time, the waters of the Río Grande generally are of acceptable quality for beneficial use on both sides of the border.<sup>29</sup> Also,

<sup>27</sup> BISHOP, "Impact of Energy Development on Colorado River Water Quality". *Natural Resources Journal*, 17 (1977), 649, 669.

<sup>28</sup> *Ibid.*

<sup>29</sup> ROHLICH, "Surface Water Quality in the Border Area Between El Paso and the Gulf of Mexico", paper given at South Padre Island, Apr. 23-24, 1981, 4.

it should be noted that in Texas a number of the border cities which discharge wastewater into the river have underway improvements to their sewage treatment plants.<sup>30</sup> Nonetheless, with greatly increasing populations, greater stress will be placed on the river. The situation can be summarized as follows:

1. The increase in population and urbanization in the Río Grande Basin will result in increasing demands on the surface water supply and also has the potential to cause serious adverse effects on water quality.<sup>31</sup>
2. Although surface water of a quality suitable for irrigation will be required in an amount much larger than for other uses, high quality water to meet increasing municipal and industrial demands will impose a severe burden on the surface water resources in the region.<sup>32</sup>
3. On the positive side is the fact that much of the population increase will be in the lower Río Grande Valley where waste water is not returned to the river, thus significantly mitigating the adverse effects of increasing population on water quality.<sup>33</sup>
4. Oyarzabal reports that salinity readings presently range from medium to high levels in the irrigation district in Mexico below Anzalduas Diversion Dam.<sup>34</sup>
5. Studies over the past fifteen years document a trend of deteriorating water quality below Amistad Dam on the mainstream of the Río Grande.<sup>35</sup>
6. If present trends continue in Anzalduas Dam in Mexico, we would reach dangerously high salinity levels of 1,320 parts per million by the year 2,000.<sup>36</sup>
7. Continued urban and industrial development has the potential to increase the contaminant levels of heavy metals.<sup>37</sup>
8. Pesticide contamination is a matter requiring continued surveillance.<sup>38</sup>

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<sup>30</sup> WHITTINGTON, "Comments on the Surface Water Quality in the Border Area Between El Paso and the Gulf of Mexico", commentary given at South Padre Island, Apr. 23-24, 1981, 6.

<sup>31</sup> ROHLICH, *loc. cit.*

<sup>32</sup> *Ibid.*

<sup>33</sup> Proceedings, Anticipating Transboundary Resource Needs and Issues, South Padre Island, Apr. 23-24, 1981.

<sup>34</sup> OYARZABAL, *loc. cit.*, 16.

<sup>35</sup> *Ibid.*

<sup>36</sup> *Ibid.*, 17.

<sup>37</sup> *Ibid.*

<sup>38</sup> *Ibid.*

Recommendations made by the United States-Mexico Study Group included:

1. The authorities on both sides of the frontier should give urgent attention to developing appropriate means of reversing the dangerous trend of worsening water quality.<sup>39</sup>
2. Analytical studies on historical water quality records must be done to detect changes in quality before serious adverse effects occur.<sup>40</sup>
3. Continuing monitoring of water quality of the Río Grande/Río Bravo must be carried out on a basin-wide scale and in a spirit of international cooperation. Information must be exchanged freely.<sup>41</sup>
4. Full cooperation should be given to the International Boundary and Waters Commission in carrying out its duties to resolve "border sanitation problems" under Minute 261 of the 1944 Treaty.<sup>42</sup>
5. Increased water conservation and transfers from water intensive uses will be necessary.

#### **MINUTE 261 AND THE EXPANDED ROLE OF THE IBWC**

In addition to the more widely publicized Colorado salinity problem, numerous other serious quality problems have arisen from transboundary rivers. For example, California residents were greatly concerned about pollution coming from Mexico. News reports declared, "Raw sewage, dead dogs, fish, and industrial waste flowing north across the Mexican border via the New River are creating a major health hazard."<sup>43</sup> Headlines announced, "New River: A Sewer from Mexico"<sup>44</sup> and "California Fights River Flow of Mexican Wastes".<sup>45</sup> The New River rises in Mexico near Mexicali and flows northward into California to the Salton Sea, southeast of Palm Springs, carrying highly contaminated water. The contamination was said to come from inadequately treated sewage and industrial discharges. The extent of the problem was such that American officials had to erect signs warning that the water was contaminated.

Arizona farmers have been concerned about pollution in the San Pedro River, which flows north from Sonora into southeastern Arizona.

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<sup>39</sup> *Ibid.*

<sup>40</sup> Proceedings, see Note 33.

<sup>41</sup> *Ibid.*

<sup>42</sup> *Ibid.*

<sup>43</sup> *Washington Post*, Dec. 11, 1978, p. A3, cols. 1-4.

<sup>44</sup> *Ibid.*

<sup>45</sup> *New York Times*, Nov. 20, 1978, p. A19, cols. 1-4.

The flows at times are extremely discolored, and farmers were worried about possible damage to agricultural land and crops. Residents were disturbed about possible health effects on themselves and their families. The likely source of this contamination was the large copper works in the Cananea area in Sonora.<sup>46</sup>

Similarly, Mexico residents have complained about the dumping of offal into the Río Grande by meat packing companies, as well as the stench drifting across the border from those companies located in El Paso.<sup>47</sup>

The IBWC has dealt with these situations and has done a great deal in identifying "border sanitation problems" and in reaching binational agreement for the building of facilities to handle international sewage problems in the border area, such as at the twin cities of Nogales, the two Nacos, and Douglas-Agua Prieta, as well as arrangements to combat the sewage problem of Tijuana.<sup>48</sup>

However, the explosive population growth in the border area has made it very difficult to keep up. At Nogales, the facilities were designed for a population of 20,000, but were overtaxed by a 1967 population of 29,000. This led the IBWC to expand the works to serve 102,000 people in 1980. Again, this probably falls short of the actual population.<sup>49</sup> The population of Tijuana has doubled or tripled every decade between 1930 and 1970,<sup>50</sup> and in Mexicali it increased 2,011 percent between 1940 and 1970.<sup>51</sup>

In addition, the mandate of the IBWC has been construed very narrowly. The geographic jurisdiction of the Commission is limited to "the limitrophe parts of the Río Grande... and the Colorado River, to the land boundary between the two countries and to works located upon their common boundary".<sup>52</sup> The subject-matter jurisdiction of the Commission was described by narrow and now outdated language in the 1944 Treaty. Section 3 of that treaty restricted its environmental

<sup>46</sup> Conversations with the Office of the Attorney General of Arizona, April 1979.

<sup>47</sup> WHITMAN, Note of Apr. 6, 1961, *Digest of International Law*, 6 (1968), 258.

<sup>48</sup> See, International Boundary and Water Commission, *History and Development of the IBWC, United States and Mexico*, 1959; See also, Mumme, "The Background and Significance of Minute 261 of the International Boundary and Water Commission", *California Western Law Journal*, 11 (1981), 223.

<sup>49</sup> VICTORIA, "Population Change in the Northern Border Area Municipios of Mexico 1970-1980", paper given at South Padre Island, Apr. 21, 1981, 6; Applegate, *Environmental Problems of the Borderlands*, 1979, Table I.

<sup>50</sup> GUTIÉRREZ, "El Desarrollo Económico y de Población en la Ciudad de Tijuana", *Natural Resources Journal*, 17 (1977), 615.

<sup>51</sup> STODDARD, *Population Changes for Selected Border Cities: 1940-1970*, 1978.

<sup>52</sup> 1944 Treaty, Art. 3.

attention to "border sanitation problems" when it called on the two governments to "give preferential attention to the solution of all border sanitation problems".<sup>53</sup>

The Commission since 1944 has narrowly construed the phrase "border sanitation problems" and has largely limited its concern to projects such as sewage disposal works and has not expanded its focus to other environmental hazards. Mumme suggests that the Commission "has interpreted its powers conservatively, in such a manner as to preclude the possibility of any serious controversy over the propriety of its jurisdiction".<sup>54</sup> Of course, one must not overlook the strategic role of the Commission in reaching a solution of the Colorado River salinity problem through Minute 242. As population and economic growth have increased, more problems have arisen, and there has been a felt need for the Commission to take a more active role in their resolution.<sup>55</sup>

As a result, on February 16, 1979, Presidents Carter and López-Portillo issued a joint communique calling upon the IBWC "to make immediate recommendations for faster progress toward a permanent solution to the sanitation of waters along the border".<sup>56</sup> The Commission responded with Minute 261.<sup>57</sup>

What does Minute 261 change?

#### A. *Broadened Authority of Commission*

In a key clause, Minute 261 provides:

That the two Governments recognize as a "border sanitations problem", ...each case in which, in the judgement of the Commission, the waters that cross the border, including coastal waters, or flow in the limittrophe reaches of the Río Grande and the Colorado River, have sanitary conditions that present a hazard to the health and well-being of the inhabitants of either side of the border or impair the beneficial uses of these waters.<sup>58</sup>

This offers the opportunity for a much broader approach to water quality problems by expanding the Commission's efforts beyond traditional

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<sup>53</sup> *Ibid.*

<sup>54</sup> MUMME, "The Background and Significance...", 223, 226.

<sup>55</sup> *Ibid.*, 229.

<sup>56</sup> White House Joint Communique of Mexican President José López Portillo and President of the United States Jimmy Carter, on the occasion of President Carter's visit to Mexico, Feb. 14-16, 1979, pp. 1-6.

<sup>57</sup> International Boundary and Water Commission, United States and Mexico, Minute 261: Recommendations for the Solution of Border Sanitation Problems, Sept. 24, 1979, El Paso, Texas.

<sup>58</sup> *Ibid.*, Par. 1.

sewage disposal works to solving any water quality problem which presents a threat to health or well-being or might impair the beneficial use of the waters. This language is broad enough to cover the range of problems from salinity to toxic industrial wastes and agricultural pesticides, as well as municipal sewage.

*B. Mandate of the governments that border water quality problems be dealt with as a matter of priority*

Minute 261 contains a great deal of language expressing a specific intent to give a sense of priority to water quality questions. The Commission is to give "permanent attention" and "immediate and priority attention" to border sanitation problems.<sup>59</sup> The governments are to "urgently" carry out the execution of remedial measures to correct specific border sanitation problems identified by the Commission with the "greatest speed and timeliness possible".<sup>60</sup>

The Commission is mandated to take the initiative on a case-by-case basis in the "identification of the problem, definition of conditions that require solution, specific quality standards which should be applied, the course of action that should be followed for its solution, and the specific time schedule for the implementation".<sup>61</sup>

Thus, Minute 261 will not, by itself, solve all border water quality problems. The delicate binational considerations and cooperation between the two governments will still have to be worked out on a case-by-case basis. Nevertheless, the mandate of the Commission is clearly extended, and the intent of the minute is for the Commission to take a greater initiative in the solving of "border sanitation problems" more broadly defined to include a wider range of water quality issues, and these initiatives are to be taken as a matter of priority.

#### SUMMARY OF PRESENT SITUATION, PROGNOSIS AND RECOMMENDATIONS<sup>62</sup>

1. The division of surface water supplies has been largely completed and has been carried out equitably and amicably by mutual agreement.

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<sup>59</sup> *Ibid.*, Par. 2.

<sup>60</sup> *Ibid.*, Par. 5.

<sup>61</sup> *Ibid.*, Par. 4.

<sup>62</sup> These suggestions were also made in a paper given at the Conference entitled "Anticipating Transboundary Resource Needs and Issues in the United States-Mexico Border Region to the Year 2000", Querétaro, México, Jan. 28-29, 1982.

2. However, the ambiguous language of the treaties for sharing shortages in times of drought carries the potential for serious conflict between the two countries as populations increase.
3. Stretching available supplies to meet increased demands will require significant conservation efforts and increased transfers from water intensive uses such as agriculture to meet municipal and industrial needs.
4. The avoidance of conflict over water quality problems will require continuing vigilance and cooperation on the part of both countries.
5. Fortunately, Minute 161 provides the IBWC increased authority to deal with water quality issues in the border region.
6. However, the IBWC will have to act with vigor and initiative to resolve the complex and difficult pollution problems which will arise from the dramatically increasing demands being placed on the drainage basins in the border region.
7. Competition for groundwater resources will increase greatly, particularly in urban areas such as El Paso-Juárez.
8. The legal authority for ensuring that each country receives its fair share of the transboundary groundwaters is nearly nonexistent. In fact, the issue has barely been addressed.
9. Given this combination of increased competition and inadequate legal protection, the likelihood for conflict likewise will increase.
10. The International Boundary and Water Commission should be given authority to identify and designate international groundwater areas and, on an aquifer-by-aquifer basis, determine the fair and equitable share of both countries of these waters, and to ensure that each country's fair share is protected.
11. The IBWC should be given authority to protect the water quality of transboundary groundwaters.

Thus, in our final assessment, we can see much that has been accomplished and much that has yet to be done to avoid new conflicts between the two countries as populations grow, demands for water increase, and new problems arise.



## CONSIDERACIONES SOBRE UN POSIBLE MARCO TEÓRICO PARA EL MANEJO DE LAS CUESTIONES ECOLÓGICAS ENTRE MÉXICO Y ESTADOS UNIDOS

JORGE A. VARGAS

Dentro del marco de sus añejas relaciones bilaterales, México y Estados Unidos de América han asignado un papel secundario y periférico a las cuestiones relativas a la investigación y preservación del medio ambiente, ya se trate en tierra, en el aire o en el agua. Así pues, el interés por el estudio y la protección del delicado entorno ecológico que se da a lo largo de la vasta frontera entre ambos países, tiene sin lugar a dudas una muy baja prioridad ya que virtualmente no se ha visto reflejado en sus relaciones diplomáticas.

En efecto, si se analizan los miles de asuntos diplomáticos que ambos países han manejado en lo que va de este siglo, se obtiene un resultado sorprendente: no pasan de dos los casos relacionados con la ecología de esa frontera común que comparten nuestras dos naciones, a pesar de que la línea divisoria internacional tan sólo en el terirtorio continental se extiende a lo largo de 3,716 kilómetros. Parecería, pues, que entre México y Estados Unidos no hay problemas asociados con la ecología de la región o bien que existe una política deliberada que ha sido diseñada para no atenderlos o para ocultarlos.

Frente a los graves y delicados problemas que México y Estados Unidos deben resolver día con día en materia de precios de petróleo y gas natural, gasoductos de México a Estados Unidos, indocumentados, tarifas arancelarias de comercio, cooperación Norte-Sur con una importante reunión en Cancún, y política exterior en Centroamérica, los asuntos que atañen a la protección del medio ambiente, las cuestiones ecológicas bilaterales simplemente desaparecen de la lista de asuntos prioritarios entre ambos países. La ecología es un tema de mínima prioridad en las relaciones internacionales entre México y Estados Unidos.

Cabría reconocer, sin embargo, que a nivel oficial los asuntos ecológicos entre ambos países sólo pueden aspirar a recibir una efímera atención en las agendas de trabajo de los funcionarios de la Secretaría

de Relaciones Exteriores o del Departamento de Estado. Esto solamente ocurre en aquellos casos —por demás excepcionales— en que la opinión pública ejerce una presión que se hace casi intolerable y que obliga a que la cuestión se conozca a niveles oficiales. La experiencia de los últimos treinta años ha puesto en evidencia que para que los asuntos ecológicos puedan tener la suerte de ser manejados oficialmente entre los dos países, es requisito *sine qua non* que tales asuntos reúnan las siguientes características:

### 1. *Ámbito espacial y temporal*

Que el problema ecológico abarque un área de considerable extensión geográfica. Éste sería el caso, por ejemplo, del pozo de exploración Ixtoc I en el Golfo de México. A medida que el daño ecológico se prolongue en el tiempo, crecerán sus posibilidades de que reciba una atención adecuada. Ésta podría ser la situación del gravísimo problema que crea en materia de salud pública para los habitantes de Ciudad Juárez, Chihuahua, la actividad contaminadora de la American Smelting and Refining Company (ASARCO), situada en El Paso, Texas.

### 2. *Impacto en la población (político y económico)*

Mientras mayores sean desde un punto de vista numérico, y por lo tanto político y económico, los efectos adversos que el fenómeno ecológico transnacional cause en un núcleo de población, mayor será también la posibilidad de que ese problema se llegue a discutir a nivel oficial. Dicho impacto puede afectar no sólo el grado de salud pública general sino también otras actividades económicas (desempleo), sociales (desplazamientos ciudadanos o cruces fronterizos) o políticas (elecciones municipales, estatales o nacionales).

Como ejemplo podría citarse el de los ocho mil niños juarenses que sufren envenenamiento de plomo por las actividades industriales de la ASARCO, frente al número relativamente pequeño de cientos de mujeres mexicanas que manejan substancias tóxicas y peligrosas en diferentes clases de maquiladoras fronterizas.

### 3. *Conocimiento del daño ecológico*

A medida que se posea información más completa y técnica sobre el daño ecológico que causa un contaminante dado, mayor será la respuesta

social, la cual estará en proporción directa con la intensidad, peligrosidad y gravedad del contaminante en cuestión. Cuando se conocen al detalle, por ejemplo, los síntomas y el envenenamiento final que los metales pesados (como el plomo) causan en el ser humano, la reacción popular es más rápida e intensa.

#### *4. Nivel de divulgación pública*

Como corolario de todo lo anterior, uno de los factores más decisivos para atraer la atención sobre un problema ecológico dado, es el nivel de conocimiento público del problema. Por lo tanto, en estos casos será fundamental el tipo y la calidad de la información que se divulgue entre la población, poniendo particular énfasis en ciertos sectores: autoridades públicas, legisladores, científicos e intelectuales, estudiantes y público en general; así como en su grado de cohesión política.

Ciertamente que esta última característica juega un papel decisivo en la captación del problema y en el conocimiento de sus efectos adversos por parte de la población. Así pues, en este campo es fundamental la divulgación que de los problemas ecológicos puedan hacer, en una circunstancia política dada, ciertas entidades como:

- a) las autoridades públicas;
- b) las instituciones científicas y académicas, incluyendo reuniones nacionales o internacionales, como la presente;
- c) los medios de difusión masiva, en particular los periódicos y la televisión; y,
- d) los grupos de protección ecológica.

Considero que un papel rector y orientador de la opinión pública en el conocimiento y análisis de cuestiones ecológicas que afectan, o pueden afectar la vida fronteriza entre México y Estados Unidos —y aun las relaciones generales bilaterales entre ambos países— son sin duda alguna los aportes científicos y académicos que se generan en ambos lados de la frontera.

Empero, me agradaría añadir que también en este campo los medios públicos de difusión, en especial los periódicos, desempeñan una muy valiosa labor. Me pregunto: ¿en qué medida los temas y cuestiones que estamos tratando aquí, en esta reunión, no fueron de algún modo sugeridos por diferentes periódicos?

Cabría añadir que el nivel de divulgación pública en relación con la variada gama de cuestiones que presentan los temas ecológicos en su acepción más amplia, es un factor capital para el conocimiento, evalua-

ción y eventual solución de los problemas vinculados con la protección y preservación del entorno físico que nos rodea, sea terrestre, aéreo o acuático. Es más, podríamos agregar que de la adecuada divulgación de estos temas se derivan consecuencias que van más allá de la solución inmediata, a corto plazo, de estos problemas, como podrían ser sus *efectos didácticos*, al enseñar al grueso de la población el interés, entendimiento y respeto por la ecología, despertando así vocaciones jóvenes que de realizarse engrosarán las filas de los especialistas y los técnicos que tanto se necesitan en este campo. Además, la divulgación ecológica contribuye a la formación de una conciencia general de tipo político, educativo, científico, etcétera, que propende a la búsqueda y formulación de políticas en materia ecológica para el futuro inmediato y aun a largo plazo.

## II. PARTICIPACIÓN DE LAS COMUNIDADES CIENTÍFICA Y ACADÉMICA

Por su propia naturaleza, los asuntos ecológicos requieren de sólidos fundamentos técnicos y científicos. Ya se trate de la determinación de la presencia de partículas contaminantes en la atmósfera o en los vientos contaminantes; en el efecto adverso que ciertas actividades humanas ocasionan en la flora o fauna circundante o bien en la presencia de substancias nocivas o contaminantes en aguas superficiales, subterráneas, o marinas, para citar casos por demás conocidos.

Mientras que la atención de estos asuntos apenas empieza a hacer sentir su presencia en el ámbito nacional, el manejo académico o científico de las cuestiones ecológicas a nivel internacional es algo apenas incipiente. Mientras que el culto a la protección del medio ambiente y el interés por las cuestiones vinculadas con la ecología produjeron un vigoroso movimiento universitario en Estados Unidos hace diez o quince años, a medida que ha pasado el tiempo el despertar de esa conciencia ecológica es aletargada de nuevo. Es cierto que en este país todavía despiertan interés los temas ecológicos, particularmente aquellos que se relacionan con las claras amenazas que presentan para el medio ambiente y para el hombre la instalación y operación de plantas generadoras de energía eléctrica basadas en reactores nucleares. Empero, la presencia de cuestiones tal vez más mundanas, como sería el caso del severo desempleo que ha venido afectando estos años a esta nación; el grave índice de inflación y, sobre todo, la alarmante carrera militarista que hace pensar en una hecatombe mundial, son temas que apartan de la ecología a los investigadores, académicos y científicos del mundo.

Por otra parte, cabe señalar que en México los temas ecológicos todavía siguen formando parte de una mera utopía. Se carece de una

clara conciencia ecológica, y los planes de desarrollo se apoyan en una acelerada industrialización. La mínima prioridad que en México reciben las cuestiones vinculadas con la protección del medio ambiente se ve claramente reflejada en el número tan escaso de proyectos de investigación científica que desarrollan en este campo las universidades mexicanas, así como los centros de investigación. Una consulta a los proyectos de investigación científica que en materia de ecología ha apoyado financieramente el CONACYT en los últimos diez años, revela que el número de tales proyectos es apenas representativo. Lo mismo puede apuntarse en relación con los proyectos que en esta área secundan otras instituciones oficiales del país, como la Secretaría de Educación Pública.

Parecería que en uno y otro país el estudio y la investigación de los problemas vinculados con la ecología se realizan sin orden ni concierto. Es decir, algunos problemas se atacan porque los indicadores de carácter político del momento, o los apoyos económicos que se obtienen, así lo demandan; sin embargo, estas actividades limitadas y esporádicas no pertenecen a un programa racional, a una acción planificada ni a mediano ni a largo plazo.

Algo más que viene a cubrir con una nube de pesimismo el tema es el hecho de que tanto en México como en los Estados Unidos de América, el marco jurídico que se aplica a las diferentes cuestiones ecológicas es diferente. Este criterio se aplica no sólo a los principios e instituciones legales, sino a los objetivos que persiguen tales ordenamientos jurídicos, en donde tal vez se encuentre la causa de la confrontación entre nuestros dos países.

Con el espíritu de contribuir no sólo a despertar la atención y el interés por la investigación de nuestros problemas ecológicos, en este momento en la región fronteriza entre México y Estados Unidos, pero sobre todo con la esperanza de apuntar a su justa solución, cabría pensar en dos proposiciones: en primer término, tratar de formular las bases ecológicas que deberían aplicarse a lo largo de la frontera entre nuestros dos países tanto en tierra, en el aire como en el agua. Si en el momento actual se carece de los elementos suficientes para formular todo un programa de preservación ambiental fronteriza en esa región, sería muy útil que los gobiernos de uno y otro país hicieran un esfuerzo por definir las bases ecológicas de su actuación en esa zona.

En segundo lugar cabe pensar en la creación de una comisión binacional México-Estados Unidos que de manera específica se ocupe del estudio de estas cuestiones. Esta comisión estaría integrada por funcionarios del sector público y por miembros de las comunidades científica y académica de cada país. Dicha comisión, además de impulsar el conocimiento objetivo de los numerosos problemas de contaminación que se presentan a lo largo de la línea divisoria internacional, aportaría reco-

mendaciones tendientes a su solución; coordinaría esfuerzos de investigación científica y académica en uno y otro país; publicaría estudios e investigaciones y, evidentemente, formularía las bases de la actuación en materia ecológica de los dos países en una vasta frontera cuya existencia se hace cada vez más sutil entre los pobladores fronterizos de México y Estados Unidos.

## COMMENTARY

GERARD A. ROHLICH

The essayists are to be comended for providing this overview of the water resource and ecological issues and problems in the border region.

In view of the extensive data base available for the region and the general recognition and agreement on many of the issues it would be desirable, at this time, to initiate the development of a comprehensive planning and management program for each of the major river basins in the region. In semi-arid to arid regions water is a unifying factor around which such a planning and management program can be developed. Many of the inadequacies and conflicts that exist at present are the result of a lack of planning in the past. It is not to say that adequate planning would prevent or resolve conflicts, but it would provide options useful in the management of conflict.

It is obvious to even those who have given only passing thought to water resource management in the border region that the technical, socio-economic, and legal problems are exceedingly complex. Nonetheless, systematic planning must be initiated if we wish to implement a rational and orderly program to approach optimum use of the resource and in turn improve the economic and social development in the region.

Comprehensive water resource planning must consider multiple objectives, multiple purposes and multiple users. A planning program will have to consider the complexity of the different goals, perspectives, and values of the many entities and individuals who have, not only genuine interest, but vested right in the water resources. Water resource planning has advanced well beyond planning for "net economic benefits to whomsoever they may occur". As indicated by our essayists consideration must be given to issues of equity, legal issues, risk, distribution of wealth, environmental quality, and social welfare as well as technical and economic sufficiency and efficiency. Proper planning requires systematic examination and evaluation of a wide range of options for presentation to political decision makers so that the economic, environmental, political and social impacts of the various alternates are clearly recognized.

Rigorous and objective analysis in a structured program can provide information on the interdependencies and interactions of the users of the resource and lead to design of control procedures and regulations.

In the past, it was virtually impossible to consider large multi-use systems because of the lack of adequate accounting systems to evaluate complex projects. The development of computers and computer-use technology for information storage and retrieval, simulation modelling, and optimization techniques have extended our capabilities to study these vast and complicated systems.

Development of conceptual models for systematic programs that identify units and factors that influence a system can include alternative methods and levels of control including budget constraints, management-control measures, and enforcement schemes that may be employed to control the level of water quality within the desired goals. Such investigations will make it possible to evaluate not only the direct costs and benefits which are normally identified but also to consider the social values which usually escape quantification.

In summary, I am suggesting that this is an appropriate time to begin a systematic water resources planning program for the major basins in the border region. As Professor Utton has suggested the IBWC should be given expanded authority and financing for the direction of the integrated planning and management study.

An advisory panel should be formed to assist in the development of the planning program. To undertake a project of this scale will be expensive, but a systemized approach is needed to address the principal issues in a regional approach to water resource management.

## COMENTARIO

JOAQUÍN BUSTAMANTE REDONDO

### I

En su trabajo, el doctor Utton dice que la Comisión Internacional de Límites y Aguas ha sido autorizada únicamente para intercambiar información y controlar las extracciones de aguas subterráneas en una zona de la frontera cerca de Yuma, de conformidad con el Acta 242. Considero que esto no es estrictamente correcto ya que las Actas de la Comisión no deben considerarse como autorizaciones a la Comisión, sino como acuerdos de la misma logrados dentro de la autoridad general que le otorga a la Comisión el Tratado de Aguas de 1944. La aprobación de las Actas por los dos gobiernos constituye una confirmación de dichos acuerdos y la aceptación de las obligaciones inherentes en los mismos por ambas partes.

También en este ensayo, punto N° 7 de las recomendaciones del doctor Utton, se dice que la explotación exhaustiva (depletion) de los acuíferos puede justificarse de la misma manera en que se justifica la explotación de los recursos minerales no renovables. Independientemente de que el criterio del doctor Utton al respecto sea o no el correcto, considero muy difícil que los acuíferos subterráneos fronterizos puedan explotarse exhaustivamente de esta manera, ya que las aguas subterráneas no tienen posición fija, pues su extracción en un sitio del acuífero provoca flujos de las aguas de otros sitios hacia éste. Por lo tanto es muy difícil limitar y definir el volumen de las aguas que le corresponderían explotar a uno u otro país.

En el punto N° 9 de las recomendaciones del profesor Utton, se dice que a la Comisión Internacional de Límites y Aguas entre México y los Estados Unidos debería otorgársele jurisdicción sobre las aguas subterráneas cortadas por el límite internacional. Considero que el Tratado de 1944 es suficientemente amplio para que la Comisión ejerza jurisdicción sobre las aguas subterráneas fronterizas, ya que en ninguna parte de los artículos 2, 3 o 24 del Tratado se limita la jurisdicción de la Comisión a las aguas superficiales.

El doctor Utton considera que la adjudicación de los recursos hidráulicos internacionales de tal manera que a cada país se le asigne una proporción equitativa de las aguas subterráneas, sería más factible que un enfoque comprensivo, debido a las sensibilidades de soberanía de los países. Considero muy atinado este criterio del doctor Utton pero muy difícil de llevar a cabo en la práctica. Creo que a la larga tendríamos forzosamente que encontrar la manera en que esto sea factible.

En otra parte de su ensayo se habla de las dificultades que podrían suscitarse en caso de alguna sequía extraordinaria en territorio de los Estados Unidos que pudiera afectar los volúmenes de agua entregados a México, de acuerdo con el Tratado de 1944. No pienso que éste pudiese ser motivo de desacuerdo en alguna ocasión, pero soy optimista con respecto a la resolución del conflicto resultante, pese a que el Tratado no especifica cómo deberá determinarse la existencia de sequía. La Convención de 1906, que adjudica a México aguas para el riego de las tierras del Valle de Juárez, también especifica que las entregas podrán reducirse en caso de extraordinaria sequía en los Estados Unidos, sin definir el término "extraordinaria sequía", ni especifica cómo se juzga dicha condición. En el caso del Valle de Juárez han sido numerosas las ocasiones en que los volúmenes entregados a México se han reducido por sequías en los Estados Unidos, y nunca ha habido conflicto por tal motivo, pues la Comisión Internacional está facultada para ejercer las medidas necesarias para comprobar la existencia de la sequía y de la reducción en los volúmenes entregados para las tierras del Valle de El Paso. Considero que en el caso del Río Colorado, la Comisión podría llegar a establecer amigablemente un sistema semejante.

Se escribe también respecto de los impactos potenciales que podría tener el desarrollo de fuentes de energía en la cuenca del Río Colorado sobre la calidad de las aguas de este río. Es indudable que el desarrollo de fuentes de energía en la cuenca del Río Colorado afectará la calidad de las aguas; sin embargo, no veo motivo para que esto sea causa de conflicto internacional, pues el Acta 242 especifica que las aguas entregadas a México para el riego de las tierras del Valle de Mexicali tendrán una relación de salinidad específica con respecto a las entregadas para el riego de los terrenos del Valle Imperial. Creo que podemos confiar en que los intereses agrícolas de los Estados Unidos tomarán todas las medidas necesarias para asegurar que las aguas entregadas al Valle Imperial sean de calidad aceptable y, por lo tanto, las aguas entregadas a México serán de calidad semejante. Así, el problema se convierte en uno nacional de los Estados Unidos, sin características internacionales.

En la última sección del ensayo se habla de que la autoridad de la Comisión ha sido ampliada por el Acta 261 en materia de problemas internacionales de saneamiento. Considero, como en el caso del Acta 242, que el Acta 261 no amplía la autoridad de la Comisión sino que únicamente

mente asienta el acuerdo de la Comisión en el sentido de dar mayor atención a los problemas internacionales de saneamiento. La aprobación de esta acta por los dos gobiernos confirma la aceptación por ambas partes de las obligaciones que de dicho acuerdo se deriven.

Finalmente se dice que la Comisión ha recibido el mandato de tomar la iniciativa en los problemas fronterizos de saneamiento. Considero que el Acta 261 no constituye un mandato para la Comisión a las instrucciones específicas que recibió de los presidentes de ambos países, para que dirigieran su atención a estos problemas con base en la autoridad con que contaba.

## II

El trabajo presentado por el doctor Vargas es de carácter bastante general, por lo cual mis comentarios también serán generales.

Al principio de su trabajo el doctor Vargas dice que es de llamar la atención que los problemas ecológicos de la frontera que comparten las dos naciones han recibido muy poca atención de los gobiernos y que virtualmente no se han visto reflejados en sus relaciones diplomáticas. Considero muy acertada la llamada de atención del Dr. Vargas y muy cierta su aseveración, de que la Secretaría de Relaciones Exteriores o el Departamento de Estado únicamente se ocupan de estos casos cuando sus efectos se vuelven intolerables para los habitantes de las zonas fronterizas y cuando la opinión pública demanda acción.

Más adelante el autor dice que en este campo de acción los medios públicos de difusión, en especial los periódicos, desempeñan una buena labor. Es indudable que la opinión pública deberá ser informada y orientada para que conozca los efectos que podrá resentir como resultado de algún problema ecológico y pueda tomar precauciones y demandar la atención necesaria al problema. Sin embargo, considero que estos medios, y en especial los periódicos, con demasiada frecuencia exageran y distorsionan los hechos al grado de que problemas sencillos y fáciles de corregir se convierten en problemas graves y difíciles.

Coincido con el doctor Vargas en su criterio de que las comunidades científicas y académicas de los dos países deberán seguir y aun intensificar sus estudios al respecto, así como la divulgación de los mismos en forma seria y consciente.

Coincidí también con el doctor Vargas en su aseveración de que cabe pensar en la creación de una comisión binacional México-Estados Unidos que de manera específica se ocupe del estado de los problemas ecológicos fronterizos. Considero que, siendo la ecología un campo tan amplio, no debe pensarse que su estudio o la resolución de sus pro-

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blemas sean adjudicados a la actual Comisión Internacional de Límites y Aguas, pues por definición ésta tiene como función atender los problemas internacionales relacionados con las aguas fronterizas, lo cual no impide que pueda actuar, dentro de su jurisdicción actual, en aquellos casos en que el uso o abuso de las aguas fronterizas originen problemas de tipo ecológico.

## SÍNTESIS DEL MODERADOR

ARTURO LICÓN

En el primer simposio que se efectuó en la Paz, Baja California, se trató el problema del agua en la región fronteriza, calificándosele como una de las grandes cuestiones entre México y los Estados Unidos. De ahí que para esta reunión se haya concretado más el tema, siendo importante estudiarlo para definir con más claridad el marco legal, el tratamiento y la explotación del recurso natural. Esto permite, por otro lado, darle continuidad al estudio de los temas más relevantes o importantes.

El primer ponente, el profesor Utton, define los tres factores principales relacionados con el agua en la zona fronteriza: una población creciente, un desarrollo en expansión y recursos de agua finitos. Todo ello dentro del contexto de una frontera internacional. Juzga que es un buen momento para considerar nuestros recursos hidráulicos —en términos tanto de cantidad como de calidad— y su manejo para hacer recomendaciones para el futuro.

Resulta evidente que una de las preocupaciones de los ensayistas y comentaristas que contribuyeron en las secciones anteriores ha sido la de coadyuvar en la identificación y definición de problemas sobre cuestiones planteadas en lo general por investigadores o personas interesadas en las relaciones entre México y los Estados Unidos. Esta práctica tiene por consecuencia el desuso de lo que podríamos llamar teorías tácitas en los grandes temas de las relaciones entre ambos países, teorías que de una u otra forma han resultado sesgadas y eventualmente han sido motivo de una percepción que dificulta, o ha dificultado, el entendimiento de las mismas. En este contexto el sector académico puede surgir como un factor real en la comprensión entre ambas naciones.

En su trabajo, el profesor ofrece propuestas para mejorar el reparto de las aguas subterráneas, particularmente en la región fronteriza de México y los Estados Unidos, observando que el agua disponible en la superficie ha sido repartida, por acuerdo mutuo, en forma amistosa y equitativa. Aunque mucho se ha logrado, "mucho queda por hacer, si queremos evitar nuevos conflictos entre los dos países, en tanto las poblaciones crecen, la demanda de agua aumenta y nuevos problemas aparecen".

En su ensayo, el profesor Vargas observa tristemente que "... México y los Estados Unidos han asignado un papel secundario y periférico a las cuestiones relativas a la investigación y preservación del medio ambiente... Frente a los graves y delicados problemas que México y los Estados Unidos deben resolver... los asuntos que atañen a la protección del medio ambiente y las cuestiones ecológicas bilaterales simplemente desaparecen de la lista de asuntos prioritarios..."

El autor del ensayo señala también que los problemas ecológicos que emergen reciben más atención si abarcan una zona de considerable extensión; si el daño se prolonga; si el fenómeno ecológico transnacional afecta en forma significativa a la salud, a la economía, o a los aspectos sociales y políticos de la región o a las comunidades; si se dispone de más información técnica sobre el daño ecológico causado y, finalmente, si se divulga adecuadamente en el medio gubernamental, en el académico y al público en general. Es necesario, en tal sentido, contar con la participación de la comunidad científica y la académica para fundamentar lo inherente en la materia.

El profesor Rohlich, por su parte, previno que el manejo de recursos hidráulicos en la región fronteriza presenta problemas técnicos, socioeconómicos y legales de una complejidad extraordinaria. Sin embargo, cree que es tiempo para principiar un programa de planificación sistemática para recursos hidráulicos, y está de acuerdo con la recomendación del profesor Utton de que se amplíen tanto la autoridad como el financiamiento de la Comisión Internacional de Límites y Aguas para que dirija un estudio de planificación integrada y de manejo.

El profesor Joaquín Bustamante manifestó no estar de acuerdo con los puntos de vista del profesor Utton respecto a varios detalles e interpretaciones. Fue mucho más optimista al afirmar que las dificultades pueden resolverse amistosamente. Considera también que el reparto de las aguas subterráneas es muy atinado, pero muy difícil de llevar a la práctica. Está de acuerdo con la observación del profesor Vargas de que "la Secretaría de Relaciones Exteriores o el Departamento de Estado únicamente se ocupan de estos casos cuando sus efectos se vuelven intolerables para los habitantes de las zonas fronterizas y cuando la opinión pública demanda acción".

Creo que la inquietud académica que se planteaba al inicio de la sesión respecto de laborar, de clarificar un marco teórico para la comprensión de los problemas relativos al agua y a su solución, nos colocan, a quienes de una u otra forma tenemos esta preocupación, un tanto en el papel del búho sabio al que hacía referencia el doctor Rohlich.\* Por

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\* Se hace referencia a un cuento de una mariposa y un búho sabio, cuento que fue utilizado por el profesor Rohlich para ilustrar un punto: los búhos sabios pueden diseñar la política fácilmente. Lo que es difícil es la implementación. (Nota del editor.)

otro lado, consideró que al Ing. Bustamante, por su posición extraacadémica (Comisario mexicano en la Comisión Internacional de Límites y Aguas), le corresponde la no muy sencilla tarea de resolverle el problema operativo a la mariposa. Creo que con la perspectiva del Ing. Bustamante, por la posición en la que se encuentra, se complementa esta visión que de manera tan profunda y amena nos han hecho los ponentes y los comentaristas.

Durante la discusión que siguió a las ponencias, el maestro García Moreno, después de elogiar los ensayos y comentarios, se adhirió al punto de vista del doctor Vargas, quien había expresado no estar de acuerdo con la afirmación del doctor Utton de calificar el Tratado de 1906 sobre Distribución de Aguas en el Valle de Juárez como equitativo. Prosigió su argumentación señalando que en dicho tratado prevaleció en parte la Doctrina Harmond, la cual establece la disposición unilateral de las aguas por el ribereño superior, disposición que constituye una negación del Derecho Internacional Fluvial. Además, agregó que "hay una cláusula por ahí", la cláusula Ex-Gracia, que implica "te doy las aguas porque quiero, no porque esté obligado por la justicia internacional o por el derecho internacional".

El profesor García Moreno expresó que en términos generales no está de acuerdo con el Tratado y que podría mencionar unas 15 observaciones técnico-jurídicas en favor de su posición, pero "... lo que pasa es que no nos queda otra. Somos la parte pobre, la parte débil, y lamentablemente hubo que firmarlo porque fue la mejor negociación que se pudo lograr; pero eso no implica que México esté conforme, ni que sea equitativo, ni que sea, en fin, justo para las dos partes...", añadiendo que también podría hablar del Tratado de 1944.

El mismo investigador, al final de su intervención, cuestiona el recurrir al establecimiento de mecanismos de cooperación internacional para dirimir tales cuestiones y cita como ejemplo "el lamentable caso del atún"; en cierto sentido podría considerarse que no tiene fe en dichos mecanismos. También, en su opinión, estima que los problemas fronterizos, incluyendo el de la contaminación, no tienen alta prioridad para los Estados Unidos; en cambio, para los mexicanos, estos problemas "son básicos, son de supervivencia". Es desafortunado que no haya coincidencia en esta prioridad por parte de los Estados Unidos.

Una persona del auditorio le formuló una pregunta al ponente Jorge Vargas, relativa al artículo 73 de la versión preliminar del tratado que México aprobó en 1978 y se llevará al Congreso de los Estados Unidos en este año; concretamente, el tratado prevé que "rocas que no pueden sostener vida humana, no deben ser utilizadas en extensión para la zona exclusiva económica de doscientas millas". La pregunta consistió en si se aplicaría el mismo principio a la isla Clarión en el Pacífico, muy importante por sus recursos y en la que la marina mexicana estableció una

base, tomando en cuenta que en Cayo Arenas y el Arrecife Alacrán, en la parte oriental del Golfo, no tienen vida humana y se encuentran en el límite.

El profesor Vargas contestó afirmando que "México, antes de suscribir el Tratado del 4 de mayo de 1978, suscribió un canje de notas, el 26 de noviembre de 1976, por el cual se establecía la zona económica exclusiva y el límite exterior, tanto en el Pacífico como en el Golfo. En ese canje de notas se establece de manera expresa que ambas partes tomarán en cuenta el papel de las islas para el trazo del límite exterior de la zona económica exclusiva. Y fue lo que hizo México en el caso de Cayo Arenas, el cual, aunque aparece marcado como un cayo (como si fueran puras rocas), en el centro del cayo existen islas que podrían ser el centro de una actividad económica dada, como ocurre con la Isla Clarión. Entonces, el hecho es que en los mapas se marca nada más como un cayo, aunque cuando se hicieron las investigaciones, representantes de Estados Unidos y México, que fueron al lugar, dieron cuenta que dentro del cayo hay unas islas habitables que podrían sostener vida propia. Por eso se permitió que desde Cayo Arenas se trazara en el Golfo de México la línea que marca el límite exterior de la zona económica exclusiva entre los dos países... Tanto México como los Estados Unidos aceptaron que se les concedería el papel adecuado a las islas en el trazo de la zona económica exclusiva. Dicho reconocimiento se hizo por escrito y se reconoció por ambas partes."

Un participante del simposio preguntó: "¿Cuál es la realidad sobre la contaminación radiactiva del Río Colorado o del Río Bravo?" Añadió una segunda pregunta "yo no sé si se puede pedir una fecha, un día, una semana, un mes, un año, en que se dé el 'breaking point' de los acuíferos, por ejemplo en lugares como El Paso-Ciudad Juárez. ¿Cuando es ese breaking point?"

Especificando que las preguntas no son fáciles de contestar, el Ing. Bustamante respondió: "En cuanto a la contaminación de las aguas de los ríos Colorado y Bravo por elementos radiactivos, le confieso que no tengo ninguna información de que exista dicha contaminación, ni sé dónde podría obtenerla. Hasta donde yo sé, no existe contaminación. Si existe, pues quién sabe dónde se pueda investigar. No lo sé."

En cuanto a la segunda pregunta, refiriéndose al agotamiento de los acuíferos subterráneos, el Ing. Bustamante dijo que "por lo general no se agotan de repente. Pueden irse agotando durante muchos años sin que nadie se dé cuenta". "Puede uno detectar ese agotamiento por el abatimiento de los niveles freáticos, pero no afecta a nadie mientras vayan bajando. Es como un hombre que va cayendo de un edificio alto. Mientras va cayendo no siente nada, va muy bien; el último metro es el que lastima. Nada más que en este caso no es exactamente así porque el último metro no se sabe dónde está. Antes de agotarse un acuífero

se advierten factores como: mayor altura de bombeo a mayor costo, mayor consumo de energía, entrada de aguas de menor calidad, ensalitramiento de tierras, etc. En fin, empiezan a surgir un montón de cosas antes de que el acuífero realmente se agote. Entonces, no es fácil decir un día, una semana, un mes o un año."

Con esta explicación del Ing. Joaquín Bustamante se dio por terminada la sesión sobre el tema del agua.

## ENGLISH SUMMARY

The moderator explains the significant role of the academic community in the achievement of understanding between the two nations. Concern with transboundary water as a shared natural resource was a major preoccupation of those participating in the initial symposium in La Paz, Baja California, and this prompted the organizers of the second conference to give the problem of water a prominent part in this meeting.

Professor Utton argued that this is a good time to consider the quantity, quality, and management of transboundary water resources. He listed as key factors the growing population, increasing economic development and finite water resources; Professor Vargas lamented the low priority which the two nations give to questions related to the study and preservation of the environment; Commentator Rohlich cautioned about the complexity of the problem, but nonetheless, he believes that the time has come to begin systematic planning for water resources. He agreed with Professor Utton that authority and funding should be provided to the International Boundary and Water Commission to enable it to direct a study for integrated planning and management. Ing. Bustamante, while differing with Professor Utton on some matters of detail and interpretation, is much more optimistic that problems which may arise can be resolved amicably.

Discussion focused on the following questions: whether or not the 1906 Treaty made an equitable distribution of water in the Valley of Juárez; on determining the use of Cays, Reefs and Islands in the determination of the 200-mile exclusive economic zone; whether or not there is evidence of radionuclear contamination in the Colorado or Río Grande Rivers; and the possibility of exhaustion of groundwater aquifers.

*SOCIAL EFFECTS*

V

EFFECTOS SOCIALES

# CONTAMINACIÓN Y SOCIEDAD: LOS PROBLEMAS OCULTOS DE LA FRONTERA NORTE

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## INTRODUCCIÓN

Es posible observar lo semejante que resultan algunos de los problemas detectados en las investigaciones de contaminantes físicos y los impactos que ellos ocasionan en el medio social. Los científicos que emprenden el estudio de un contaminante físico requieren de suficiente tiempo para efectuar análisis detallados y hacer comparaciones, antes de concluir si los efectos que de él se esperan son o no ciertos. También deben recurrir a variados instrumentos para medirlo, diseñar rigurosos experimentos y controles estadísticos con el fin de saber si sus efectos deben considerarse nocivos o no: igualmente necesitan conocer los controles sobre los niveles de ese contaminante en la naturaleza y hasta los grados de tolerancia que tiene el ecosistema ante su presencia.

Los científicos enfrentan graves dificultades cuando tratan de cuantificar los efectos de un contaminante y no disponen de suficiente información sobre todos los aspectos antes mencionados. Los problemas se acrecientan si el posible contaminante produce efectos en el largo plazo; o si son difíciles de medir; o si no hay acuerdo sobre los tipos o niveles ambientales que pueden tolerarse dentro de una situación dada. Otros problemas no menos importantes se presentan al querer determinar qué poblaciones de un ecosistema serán afectadas por dicho contaminante. Como se observa, el asunto no es tan simple; es necesario precisar la situación espacial y temporal de los impactos que se causarán.

La incertidumbre que existe en las ciencias en torno a los efectos que ocasiona la contaminación en el medio ambiente, adquiere una mayor dimensión cuando se abordan otros efectos menos entendidos: los de tipo socioeconómico. Por principio de cuenta, sabemos que la mayoría de los impactos sociales de la contaminación son de largo plazo y que no son fáciles de medir. También sabemos que no existe todavía (y a lo mejor ni puede existir) acuerdo sobre los niveles de contaminación que resultan aceptables desde las múltiples perspectivas políticas,

económicas y sociales. Y finalmente, es sumamente difícil determinar la importancia relativa de un contaminante sobre un proceso social, político y económico, por la fuerte interrelación que existe entre las distintas variables que se involucran en el análisis.

Por esta razón, cuando se plantean y discuten algunos de los problemas sociales más agudos de las zonas fronterizas afectadas por la contaminación del medio ambiente, es necesario señalar que resulta ahora imposible ofrecer estadísticas precisas que ilustren la gravedad de sus efectos con relación a sus impactos físicos. Una revisión realista tiene que ser así.

#### **EL PROBLEMA DE LA SELECTIVIDAD**

En cambio, en este trabajo se da énfasis a una importante característica de los efectos socioeconómicos de la contaminación: la selectividad. Una lección básica que se aprende de la contaminación en las ciencias físicas es que ella no afecta a un ecosistema en general, sino que lo hace *selectivamente*. Esta selectividad se refiere al hecho de que diferentes tipos de contaminación afectan a algunas especies más que a otras, a algunos lugares más que a otros, y que varían sus impactos temporales. Por ejemplo, la contaminación del agua en una cuenca no incide en toda ni en forma uniforme, sino que recae en los usuarios de dicha agua situados río abajo del punto de contaminación.

Con base en las consideraciones anteriores, en este trabajo queremos hacer énfasis en lo siguiente:

- a) Los efectos socioeconómicos, al igual que sucede en física, se hallan caracterizados por factores de selectividad;
- b) Que la selectividad es bidireccional desde el punto de vista de causa y efecto. Esto quiere decir que los factores económicos, culturales, demográficos y políticos afectan la cantidad y calidad de los contaminantes en una región, mientras que dicha contaminación también afecta la situación sociocultural, económica demográfica y política. Y finalmente,
- c) Que dichos factores de selectividad aumentan el grado de dificultad para controlar las causas y los efectos de contaminación en la frontera.

##### *1. Selectividad económica*

En este caso, se expresa por el hecho fundamental de que los costos de las actividades que producen la contaminación no se distribuyen

equitativamente entre los que reciben los beneficios de dichas actividades. Este hecho es un patrón que corresponde no solamente a la zona fronteriza, sino que es parte del estilo de desarrollo que se observa en todas las naciones capitalistas industrializadas. Las actividades económicas que caracterizan a la sociedad moderna (como la generación de electricidad, el uso de insumos químicos industrializados en la agricultura, el transporte individual y la protección de la población ante los cambios climáticos) generan productos tan dañinos como benéficos. Una actitud política completamente opuesta a la contaminación, al costo que sea, es contraproducente ya que en realidad va en contra de los mismos beneficios que brinda la civilización industrial. Tales productos tienen que ser desechados de alguna manera.

Pero si ellos no tienen ninguna otra utilidad productiva y causan daños a otros bienes o a los seres humanos, entonces representan costos desde el punto de vista económico. El problema económico básico de la contaminación radica precisamente en determinar quién es el que paga dichos costos. Si son transferidos de un sector económico a otro, o de una localidad a otra, o de una clase social a otra, o de una generación a otra, entonces esos costos representan *subsidios* (aunque ocultos) que paga el contaminado al contaminador. Ahora bien, los reglamentos ambientales que internamente se hallan vigentes en México y Estados Unidos pueden considerarse como acuerdos unilaterales y políticos sobre el tamaño aceptable de dichos subsidios (los reglamentos sobre aire puro, contaminación del agua, etc.). Sin embargo, dichos reglamentos solamente son aplicables dentro de las respectivas fronteras y en ningún caso representan leyes tan poderosas que frenen los subsidios completamente. De esta manera, los reglamentos vigentes en un país pueden pasar los costos de la contaminación a los sectores económicos, clases o localidades del otro país.

Dichos subsidios son comunes para la frontera, aunque su aspecto específico no es aún muy claro. Concretamente, los impactos económicos de la contaminación fronteriza han sido difíciles de determinar y no existe ningún estudio que muestre los costos directos o indirectos que ella ocasiona en el amplio campo de la actividad económica.

Para ejemplificar sobre esta perspectiva, consideremos aquí una región específica: la ubicada entre El Paso-Ciudad Juárez y la frontera California-Arizona-Sonora, y solamente una contaminación: la del aire. Las investigaciones de Applegate y Bath (1974, 78), Gómez *et al.* (1974) y las de las universidades fronterizas (Jamaíl y Ullery, 1980) han refinado las variables del problema de la contaminación fronteriza en dicha región. Sabemos, por ejemplo (Shoultz en Applegate y Bath, 1974, y Applegate y Bath, 1978), que la contaminación del aire se relaciona con la generación de SO (óxidos de azufre), y la emisión de partículas de CO (monóxido de carbono) y NO (óxido de nitrógeno).

Por su parte, Nobile y Deedy citan pruebas que indican cómo altos niveles de partículas aumentan las reacciones químicas, obscurecen la visibilidad, causan la corrosión de metales y agudizan los problemas respiratorios. El óxido de azufre (SO) puede causar daños a las hojas de las plantas y enfermedades en diferentes especies de árboles; también problemas respiratorios, destrucción de pigmentos de la pintura, la corrosión de piedra, metal y otros materiales utilizados en la construcción, destruye ropas y textiles, piel y papel (1972). En términos económicos, dicha contaminación incrementa la depreciación real del capital. Y según el principio de la selectividad económica, los que sufren más los efectos de tal depreciación son los que tienen más capital. Aunque todavía no se ha hecho el análisis, es posible cuantificar el costo de la contaminación en términos del rendimiento limitado de maquinaria, automóviles, casas, ropa y otros productos materiales.

Pero aún de mayor importancia es saber que la contaminación disminuye la calidad de la vida humana. Todavía niveles más bajos de una mezcla de óxidos de azufre y partículas que los hallados por investigadores en el área de El Paso y Ciudad Juárez son capaces de incrementar la mortalidad en personas mayores de 50 años, a la vez que acrecentar las enfermedades respiratorias de los niños en edad escolar. Y en un caso excepcional, se llegó ya al punto de causar daños directos a niños, tal y como hoy día sucede en esa misma área con la contaminación de plomo. Los que sufren más en su salud son los menores y mayores de edad. En la población de la zona fronteriza, el grupo México-Norteamericano residente en el lado estadounidense y las clases pobres del lado mexicano son más numerosos que la anglosajona. En una perspectiva económica de largo plazo, humanística y global, son precisamente las poblaciones que representan nuestro futuro como naciones o guardan nuestra herencia. Ellas son las que sufren más por dichos efectos. Asignar un costo a esta variable tan importante es sumamente difícil. ¿Cuánto vale el decremento en oportunidades futuras de los niños afectados por la contaminación de plomo en El Paso y Ciudad Juárez? Quizá, entre ellos habría futuros ingenieros, profesores, periodistas, líderes, que nunca podrán desarrollar plenamente sus potencialidades. Si miramos desde la perspectiva de que el capital humano es uno de los recursos renovables de máxima importancia para una sociedad, estos daños tienen que considerarse seriamente y en toda su dimensión.

## 2. Selectividad demográfica

La zona fronteriza se caracteriza por altas tasas de crecimiento de la población (ver cuadros del 1 al 5). Este hecho se debe a factores diferentes que operan en ambos lados de la frontera: la migración hacia

**Cuadro 1**

**POBLACIÓN DE LOS ESTADOS FRONTERIZOS DE MÉXICO**

Estado	1960	1970	1980	Tasa de crecimiento *	Tasa de crecimiento *
				1960-1970	1970-1980
Baja California	520,165	870,421	1,225,436	5.04	3.47
Sonora	783,378	1,098,720	1,498,951	3.45	3.15
Chihuahua	1,226,793	1,612,525	1,933,856	2.75	1.83
Coahuila	907,734	1,114,956	1,558,401	2.10	3.40
Nuevo León	1,078,848	1,694,689	2,463,298	4.65	3.81
Tamaulipas	1,024,182	1,456,858	1,924,934	1.70	2.82
<b>TOTAL:</b>	<b>5,541,100</b>	<b>7,848,169</b>	<b>10,604,856</b>	<b>3.55</b>	<b>3.05</b>

\* La tasa de crecimiento es por cada millón de habitantes.

FUENTE: Los datos correspondientes a 1960 y 1970 provienen de los censos generales de población de dichos años; y fueron publicados por la Dirección General de Estadística de la Secretaría de Industria y Comercio. Los datos de 1980 provienen de la Coordinación General de los Servicios Nacionales de Estadística, Geografía e Informática, dependiente de la Secretaría de Programación y Presupuesto y del Consejo Nacional de Población.

**Cuadro 2**  
**POBLACIÓN DE LOS MUNICIPIOS DE LA FRONTERA DE MÉXICO**

Municipio	1960	1970	1980	Tasa de crecimiento 1960-1970	Tasa de crecimiento 1970-1980
<i>Estado de Baja California</i>					
Tijuana	165,690	340,583	728,514	7.9	7.78
Tecate	8,208	18,091	42,049	8.8	8.80
Mexicali	281,353	396,324	559,053	3.5	3.49
<b>TOTAL:</b>	<b>455,231</b>	<b>754,998</b>	<b>1,329,616</b>	<b>5.3</b>	<b>5.82</b>
<i>Estado de Sonora</i>					
San Luis Río Colorado	42,134	63,604	96,901	4.3	4.30
Puerto Peñasco	5,741	12,436	28,376	8.6	8.59
Caborca	12,400	28,971	72,455	9.6	9.59
Altar	2,974	3,886	5,073	2.7	2.70
Saric	1,787	2,321	3,032	2.7	2.70
Nogales	39,812	53,494	71,892	3.0	3.0
Santa Cruz	1,303	1,657	2,054	2.3	2.29
Cananea	21,048	21,315	21,483	0.1	0.078
Naco	3,559	4,200	4,806	1.7	1.35
Aqua Prieta	17,248	23,272	31,580	3.1	3.09
<b>TOTAL:</b>	<b>148,006</b>	<b>215,136</b>	<b>337,652</b>	<b>3.80</b>	<b>4.61</b>

**Cuadro 2 (Continúa)****POBLACIÓN DE LOS MUNICIPIOS DE LA FRONTERA DE MÉXICO**

Municipio	1960	1970	1980	Tasa de crecimiento 1960-1970	Tasa de crecimiento 1970-1980
<i>Estado de Chihuahua</i>					
Janos	4,397	7,028	11,358	4.9	4.89
Ascensión	6,034	9,316	14,316	4.5	4.49
Juárez	276,995	424,135	652,392	4.4	4.39
Guadalupe	9,120	9,593	10,083	0.5	0.49
Ojinaga	6,545	7,950	9,691	2.2	1.99
<b>TOTAL:</b>	<b>20,373</b>	<b>25,560</b>	<b>52,085</b>	<b>2.5</b>	<b>2.29</b>
<i>Estado de Coahuila</i>					
Ocampo	8,260	9,934	11,991	1.9	1.89
Acuña	22,317	32,500	47,649	3.9	3.90
Jiménez	7,113	8,445	10,093	1.8	1.79
Piedras Negras	48,408	46,698	38,078	-0.4	-2.01
Guerrero	3,391	2,650	325	-2.5	-18.92
Hidalgo	1,040	619	2	-5.4	-43.64
<b>TOTAL:</b>	<b>90,529</b>	<b>100,846</b>	<b>108,138</b>	<b>1.0</b>	<b>0.72</b>

**Cuadro 2** (Continúa)

**POBLACIÓN DE LOS MUNICIPIOS DE LA FRONTERA DE MÉXICO**

Municipio	1960	1970	1980	Tasa de crecimiento 1960-1970	Tasa de crecimiento 1970-1980
<i>Estado de Nuevo León</i>					
Colombia	446	370	80	-1.9	-14.19
<i>Estado de Tamaulipas</i>					
Nuevo Laredo	96,043	151,253	239,426	4.7	4.70
Guerrero	4,237	4,249	4,249	0.0	0.0
Mier	5,194	6,193	7,403	1.8	1.80
Miguel Alemán	12,872	18,218	25,947	3.6	3.59
Camargo	14,319	15,416	16,691	0.8	0.80
Gustavo Díaz Ordaz	15,000	18,261	22,260	2.0	1.99
Reynosa	134,869	150,785	240,977	4.8	4.80
Río Bravo	40,000	71,389	129,056	6.1	6.09
Valle Hermoso	42,984	42,287	38,225	-0.2	-1.0
Matamoros	143,043	186,146	242,973	2.7	2.7
<b>TOTAL:</b>	<b>508,591</b>	<b>664,198</b>	<b>967,209</b>	<b>2.7</b>	<b>3.82</b>

FUENTE: Para 1960 y 1970, se elaboraron con base en las cifras que ofrece Margarita Notasco en su estudio *Migración Municipal en México (1960-1970)*, Instituto Nacional de Antropología e Historia, México, 1979. Los correspondientes a 1980 pertenecen al proyecto *Trabajo y Migración en la Frontera Norte*, Centro de Ecodesarrollo, México, 1981.

**Cuadro 3**

**POBLACIÓN, FUERZA DE TRABAJO Y EMPLEO EN LAS PRINCIPALES CIUDADES  
DE LA FRONTERA NORTE DE MÉXICO. 1980**

Ciudades	Población total <sup>1</sup>	Población económicamente activa, PEA <sup>2</sup>	Ocupados en maquiladoras <sup>3</sup>	Desocupados <sup>4</sup>	Obreros de maquila, en relación a la PEA <sup>3,2</sup>
					5
Tijuana	593,010	163,077	10,889	9,214	6.67
Tecate	34,269	9,423	560	532	5.94
Mexicali	371,770	102,237	7,965	5,776	7.79
<b>SUBTOTAL BAJA CALIFORNIA:</b>	<b>999,049</b>	<b>274,737</b>	<b>19,414</b>	<b>15,522</b>	<b>—</b>
San Luis Río Colorado	76,164	20,945	399	1,183	1.90
Nogales	70,023	19,256	12,183	1,088	63.26
Agua Prieta	28,169	7,746	4,123	438	53.22
<b>SUBTOTAL SONORA:</b>	<b>174,356</b>	<b>47,947</b>	<b>16,705</b>	<b>2,709</b>	<b>—</b>
Ciudad Juárez	596,453	168,199	36,206	7,233	21.52
<b>SUBTOTAL CHIHUAHUA:</b>	<b>596,453</b>	<b>168,199</b>	<b>36,206</b>	<b>7,233</b>	<b>—</b>
Acuña	44,861	12,544	2,738	724	21.83
Piedras Negras	33,470	9,472	2,676	546	28.25
<b>SUBTOTAL COAHUILA</b>	<b>77,831</b>	<b>22,016</b>	<b>5,414</b>	<b>1,270</b>	<b>—</b>

Cuadro 3 (*Continúa*)

**POBLACIÓN, FUERZA DE TRABAJO Y EMPLEO EN LAS PRINCIPALES CIUDADES  
DE LA FRONTERA NORTE DE MÉXICO. 1980**

Ciudades	Población total <sup>1</sup> 1	Población económicamente activa, PEA <sup>2</sup> 2	Ocupados en maquiladoras <sup>3</sup> 3	Desocupados <sup>2</sup> 4	Obreros de maquila, en relación a la PEA <sup>3,2</sup> 5
Nuevo Laredo	235,595	66,673	1,821 <sup>4</sup>	3,847	2,73
Reynosa	227,729	64,447	4,237	3,719	6,57
Matamoros	193,291	54,701	15,894	3,156	29,06
<b>SUBTOTAL TAMAULIPAS:</b>	<b>656,615</b>	<b>185,821</b>	<b>21,952</b>	<b>10,722</b>	<b>—</b>
<b>Total:</b>	<b>2,504,304</b>	<b>698,720</b>	<b>99,691</b>	<b>37,456</b>	<b>14,26</b>
República Mexicana	67,405,703	18,064,728	111,365 117,844 <sup>5</sup>	1,065,819	0,62 0,65 <sup>5</sup>

## NOTAS:

<sup>1</sup> Población ajustada con base en el X Censo General de Población. 1980. Datos preliminares, por estados. S.P.P. México, 1980.

<sup>2</sup> Población calculada considerando las tasas arrojadas por la Encuesta continua sobre empleo (SPP, 3er. trimestre de 1980) y por regiones. Para el noreste: 27.5% tasa bruta de participación y 5.65% de desocupación abierta. Para el norte, 28.2% tasa bruta de participación y 4.30% de desocupación abierta. Para el noreste, 28.3% tasa bruta de participación y 5.77% tasa de desocupación abierta.

<sup>3</sup> FUENTE: SPP. Datos para 1979.

<sup>4</sup> Cifra dudosa.

<sup>5</sup> Datos preliminares para 1980, SPP.

FUENTE: Centro de Ecodesarrollo. Proyecto: *Trabajo y Migración en la Frontera Norte de México*, 1981.

**Cuadro 4**  
**ESTADOS UNIDOS: POBLACIÓN DE LOS ESTADOS FRONTERIZOS**

Estado	1960	1970	1980	Tasa de	Tasa de
				crecimiento 1960-1970	crecimiento 1970-1980
California	15.717,104	19.953,562	23.668,562	2.40	1.75
Arizona	1.302,161	1.770,900	2.717,866	2.60	4.40
Nuevo México	951,023	1.016,000	1.299,968	0.04	2.50
Texas	9.579,677	11.196,730	14.228,583	1.55	2.40
<b>TOTAL:</b>	<b>27.550,065</b>	<b>33.936,764</b>	<b>41.914,779</b>	<b>2.10</b>	<b>2.15</b>

FUENTE: Para 1970, Censo de Población. U. S. Department of Commerce Social and Economic Statistics Administration.

Para 1980, Reporte Preliminar, 1980 Census of Population and Housing. Issued March 1981.

**Cuadro 5**  
**POBLACIÓN DE LOS MUNICIPIOS DE LA FRONTERA DE ESTADOS UNIDOS**

Municipio	1960	1970	1980	Tasa de crecimiento 1960-1970	Tasa de crecimiento 1970-1980
<i>Estado de California</i>					
San Diego	1,033,011	1,357,854	1,861,846	2.75	3.20
Imperial	72,105	74,492	92,110	0.30	2.15
<b>TOTAL:</b>	<b>1,105,116</b>	<b>1,432,346</b>	<b>1,953,956</b>	<b>2.65</b>	<b>3.15</b>
<i>Estado de Arizona</i>					
Yuma	46,235	60,827	90,554	2.80	4.10
Pima	265,660	351,667	531,263	2.80	4.25
Santa Cruz	10,808	13,966	20,459	2.60	3.90
Cochise	55,039	61,910	86,717	1.15	3.45
<b>TOTAL:</b>	<b>377,742</b>	<b>488,370</b>	<b>728,993</b>	<b>2.60</b>	<b>4.10</b>
<i>Estado de Nuevo México</i>					
Hidalgo	4,961	4,734	6,049	-0.50	2.50
Luna	9,839	11,706	15,585	1.75	2.90
Doña Ana	59,948	69,773	96,340	1.50	3.30
<b>TOTAL:</b>	<b>74,748</b>	<b>86,213</b>	<b>117,974</b>	<b>1.40</b>	<b>3.20</b>

Cuadro 5 (Continúa)

## POBLACIÓN DE LOS MUNICIPIOS DE LA FRONTERA DE ESTADOS UNIDOS

Municipio	1960	1970	1980	Tasa de crecimiento 1960-1970	Tasa de crecimiento 1970-1980
<i>Estado de Texas</i>					
El Paso	314,070	359,291	479,899	1.35	2.95
Hudspeth	3,343	2,392	2,728	3.40	1.30
Jeff Davis	1,582	1,527	1,647	-0.35	0.75
Presidio	5,460	4,842	5,188	-1.20	0.70
Brewster	6,434	7,780	7,573	1.90	-0.30
Terrell	2,600	1,940	1,595	-2.95	-2.00
Val Verde	24,461	27,471	35,910	1.15	2.75
Kinney	2,452	2,006	2,279	-2.00	1.30
Maverick	14,508	18,093	31,398	2.25	5.80
Webb	64,791	72,859	99,258	1.15	3.10
Zapata	4,393	4,352	6,628	-0.10	4.30
Starr	17,137	17,707	26,266	0.30	4.45
Hidalgo	180,904	181,535	283,229	0.00	4.60
Cameron	151,098	140,368	209,680	-0.75	4.10
<b>TOTAL:</b>	<b>793,233</b>	<b>842,163</b>	<b>1,194,278</b>	<b>0.60</b>	<b>3.55</b>

FUENTE: Para 1970, Censo de Población. U. S. Department of Commerce Social and Economic Statistics Administration. Bureau of the Census. Para 1980, Census of Population and Housing Preliminary Reports. U. S. Department of Commerce. Bureau of the Census.

"la zona del sol" en el caso de los Estados Unidos y la atracción por empleo y una fuerte migración rural hacia las áreas urbanas en el de México (Nolasco, 1980, Weaver y Downing, 1976).

A nivel general, es posible afirmar que la contaminación física es un producto de las civilizaciones industriales y la población existente en un momento dado. Joaquín Telloz (1972) sostiene que cualquier núcleo urbano de más de 50,000 habitantes es susceptible a la contaminación del aire. En la zona fronteriza, esta situación caracteriza a 20 "ciudades gemelas". Y señala cómo en un estudio realizado en 1969 demostró que en 21 ciudades fronterizas la recolección de basura ascendía a más de 1,200 toneladas diariamente. En Nogales, Sonora, el exceso de basura y polvo agravaron el problema de la contaminación de la ciudad en 1981. Como resultado, hubo un incremento en enfermedades tales como la gastroenteritis, la amigdalitis y las alergias. Supuestamente, si aumenta la población, lo hace también la contaminación. Sin embargo, dicha generalización no es suficientemente detallada por los encargados de controlar y observar sistemáticamente este problema. Ellos necesitan determinar los impactos específicos de la contaminación sobre los factores demográficos y viceversa.

Respecto a los efectos de la contaminación sobre las variables demográficas, se enfrenta un problema metodológico que no es simple. Se buscan contaminantes específicos que cambian las tasas de mortalidad o fecundidad de una población. Con la excepción de casos dramáticos, como la contaminación diaria que sufren especialmente los niños en Ciudad Juárez y originada en la fábrica de plomo establecida en El Paso, la mayoría de los impactos son de largo plazo y difíciles de detectar.

Por el contrario, los efectos que causan los factores demográficos sobre la contaminación son más fáciles de determinar. Un tipo de contaminación relacionada con el tamaño de la población es aquel ocasionado por automóviles. Se supone que un aumento de la población trae aparejado el del número de vehículos y la cantidad de contaminantes, como CO y diversas partículas. Sin embargo, la existencia de automóviles en ambos lados de la frontera demuestra que su número *per capita* y en términos absolutos es mucho más elevado entre la población norteamericana que entre la mexicana (ver cuadros 6 y 7). Por eso, un aumento de población en el lado norteamericano resulta en una mayor contaminación ocasionada por vehículos automotores que la que pudiera originarse en el lado mexicano ante un aumento similar de población.

### 3. Selectividad sociocultural

Igual que en el caso demográfico, la selectividad sociocultural de la contaminación puede considerarse, 1) desde el punto de vista de los fac-

**Cuadro 6**

**VEHÍCULOS AUTOMOTORES EN CIRCULACIÓN EN LOS PRINCIPALES MUNICIPIOS DE LA FRONTERA NORTE DE MÉXICO. 1981**

<i>Estado</i>	<i>Total registrados *</i>	<i>Habitantes por vehículo</i>
<i>Baja California Norte</i>		
Mexicali	14,536	38.46
Tecate	15,000	2.80
Tijuana	110,000	6.62
<i>Sonora</i>		
Agua Prieta	991	31.87
Caborca	12,275	5.90
Cananea	5,898	3.64
Nogales	20,000	3.59
<i>Chihuahua</i>		
Ciudad Juárez	260,000	2.51
<i>Tamaulipas</i>		
Ciudad Camargo	1,911	8.73
Ciudad Mier	1,600	4.63
Gustavo Díaz Ordaz	1,489	14.95
Matamoros	42,000	23.44
Nuevo Laredo	45,000	5.32
Reynosa	111,000	2.17
Río Bravo	10,000	12.91

\* El número de vehículos "flotantes" asciende en total a más de 200,000 para los municipios aquí incluidos.

FUENTE: Secretaría de Hacienda y Crédito Público, Dirección General del Registro Federal de Vehículos.

Cuadro 7

**COMPARACIÓN DE VEHÍCULOS AUTOMOTORES EN CIRCULACIÓN  
DE LA FRONTERA NORTE DE MÉXICO Y ESTADOS UNIDOS**

Lugares			Total Auto. registrados		Habitantes por vehículo	
	México	EE. UU.	México	EE. UU.	México	EE. UU.
Ciudad Juárez	El Paso	260,000	289,848	2.51	1.53	
Nogales	Santa Cruz	20,000	15,061	3.59	1.27	
Agua Prieta	Cochise	991	62,742	31.87	1.25	
Mexicali	Yuma Co.	14,536	74,073	38.46	1.02	
Nuevo Laredo	Webb Co.	45,000	51,547	5.32	1.67	
Reynosa	Hidalgo	10,000	156,152	12.91	1.51	
Matamoros	Cameron	42,000	113,483	23.44	1.56	

FUENTE: Secretaría de Hacienda y Crédito Público, Dirección General del Registro Federal de Vehículos, Statistical Abstract a 1979 Data Handbook, y Texas Fact Book 1981.

Datos por Texas (1979), Arizona (1978), y México (1981).

tores socioculturales afectados por la contaminación y 2) desde el de los factores socioeconómicos que afectan la contaminación. Como mencionamos antes, los impactos son bidireccionales.

Un punto bien reconocido por los investigadores que se dedican a estudiar la contaminación es la gran diferencia que existe entre los problemas de un país a otro, de una región a otra, de una ciudad a otra y de un grupo social a otro dentro de una misma ciudad. Aunque se piensa no obstante, que los diferentes efectos sobre la sociedad por la cantidad y calidad de la contaminación son simplemente una consecuencia de las distintas actividades económicas que se observan en dichas áreas.

Como parte de los proyectos conjuntos que efectúan el Centro de Ecodesarrollo (CECODES) de México y la Universidad de Arizona, se efectúan dos investigaciones paralelas para determinar los hábitos de consumo de la población a través del análisis de desechos sólidos (basura), algunos de los cuales contribuyen a la contaminación del medio ambiente. Conocido popularmente como *el proyecto de la basura*, los participantes del trabajo en Estados Unidos descubrieron que "existe una variabilidad en la corriente de desechos sólidos domésticos que se relaciona directamente con el ingreso de los hogares" (Rathje y Wilson,

1978). Recurriendo al análisis directo de la composición de la basura doméstica en Tucson, Arizona, demostraron que los hogares tiran cantidades astronómicas de papel, revistas, periódicos, vidrio, aluminio, latas, plásticos y materiales orgánicos. Se encontró que las clases medias botan mucho más desperdicios férricos y de plástico que las pobres. Mientras que en barrios con altas tasas de pobreza, se halló que había más desperdicios de materiales orgánicos. En números absolutos, las cifras son impresionantes. Por ejemplo, en 3.5 días analizados, un barrio de 10,000 habitantes de la clase media en Tucson desechó 23,000 periódicos, 33,600 revistas, 66,800 latas de aluminio y 178,000 artículos de plástico. Mientras que en un barrio más pobre, con el mismo número de habitantes, se desechó aproximadamente 10% menos periódicos, 15% menos revistas, 100% menos materiales férricos y 28% menos materiales plásticos. Pero tiraban 23% más material orgánico que la clase más rica. La contribución de dichos desechos a la contaminación depende, por supuesto, de los sistemas utilizados por los municipios para tratarlos.

Por su parte, en el estudio sobre desechos sólidos llevado a cabo en el Distrito Federal por el Centro de Ecodesarrollo y patrocinado por el Instituto Nacional del Consumidor, se encontró que, comparando estratos económicos similares de Tucson y del Distrito Federal, se observan diferencias similares a las detectadas por el proyecto de la Universidad de Arizona. En México se desechan muchas más materias orgánicas (en algunos casos cerca de diez veces más) y menos materiales férricos (hasta 24%) que en Tucson. Estos datos hacen pensar que los factores que actúan sobre la composición material de los desechos sólidos no son únicamente de tipo económico sino también ambientales, porque las zonas que se comparan en Tucson y el Distrito Federal tienen el mismo ingreso. En ambas ciudades los factores a considerar son probablemente la disponibilidad de ciertos alimentos, hábitos culturales relacionados con el consumo y métodos en la utilización de objetos de consumo; esto implica que las diferencias observadas entre estratos económicos en Tucson no tienen necesariamente una relación causa-efecto con el ingreso, y que el impacto ambiental de los desechos sólidos de una población urbana se relacionan con factores culturales y hábitos de consumo.

Este novedoso método de análisis de la realidad es muy útil para los estudios sobre la selectividad de la contaminación. La situación hallada en Tucson y el Distrito Federal no es tan sencilla como para afirmar que las clases ricas contaminan más que las pobres o viceversa; lo importante ha sido comprobar que la composición de la contaminación varía entre clases. Contaminantes graves, como plomo, que se encuentra en la tinta de revistas de color, es más común entre las clases más ricas, mientras que los contaminantes orgánicos se encuentran más entre las clases pobres. Es lamentable que no existan datos más precisos que permitan comparar y controlar, con la misma metodología, la situación

de desechos sólidos domésticos en las ciudades gemelas de la frontera. Dicha investigación, junto con otras, pueden ser muy útiles para determinar la selectividad sociocultural de la contaminación por tal tipo de desechos domésticos.

De todas formas, en México existe una contaminación social fácilmente detectable. Se trata de aquella derivada de: *a)* el fecalismo al aire libre (casas que tienen o no cualquier clase de equipo sanitario); *b)* la presencia de drenaje; *c)* la existencia del servicio de agua entubada.

Las investigaciones conjuntas que desde 1977 realizan en las ciudades fronterizas el Centro de Ecodesarrollo y Proyectos Especiales de Investigación del Instituto Nacional de Antropología (PEI-INAH), ofrecen al respecto datos muy reveladores. Para exemplificar, incluimos aquí los resultados obtenidos en una de ellas, Tijuana, pero que resultan similares también para Ciudad Juárez, Mexicali y Nogales (ver cuadros 8, 9 y 10). Los hallazgos son mucho más reveladores que los que se pueden derivar del análisis de basura.

Acerca de los efectos sociales directos que sobre la calidad de la vida ocasiona la contaminación en la zona fronteriza, existen pocas investigaciones y ningún proyecto que ofrezca buenos datos sobre un área determinada y para el largo plazo. Hay grandes diferencias socio-culturales al interior de los dos países y sus pueblos fronterizos. Entre las que posiblemente tendrán efectos notables sobre el medio ambiente se incluyen las formas de desperdicio en el hogar (importante dado el mejoramiento de los solares caseros y los terrenos baldíos que dan a la calle), cantidad de desechos *per capita* y uso de parques y jardines entre los dos grupos étnicos. Faltan estudios sobre estos hábitos socio-culturales y sus impactos ambientales que demuestren la selectividad que opera en la distribución de los efectos de la contaminación y respecto a las condiciones del medio ambiente entre diferentes grupos de ambos lados de la frontera.

Uno de los pocos trabajos realizados sobre los aspectos anteriores estuvo a cargo de dos antropólogos que investigaron las condiciones del medio ambiente social en la comunidad fronteriza de Douglas, Arizona, gracias al patrocinio del extinto Departamento norteamericano de Salubridad Fronteriza (Weaver y Downing, 1973). Aunque ubicada en el lado norteamericano, la mayoría de los habitantes de Douglas son de origen mexicano (más del 70% en 1974) y más del 20% de la población son ciudadanos mexicanos. Utilizando varios indicadores socioeconómicos, se encontró que esta población vivía en pésimas condiciones en comparación con los anglosajones.

Uno de los objetivos de tal estudio fue conocer el grado de satisfacción de los ciudadanos de Douglas con su medio ambiente personal y vecinal. Antes de llevar a cabo la investigación, el Departamento de Salubridad Fronteriza de los Estados Unidos había realizado un análisis

Cuadro 8

TIPO DE VIVIENDA Y DOTACIÓN DE EQUIPO SANITARIO EN CIUDADES PERDIDAS DE TIJUANA

Equipo sanitario	TIPO DE VIVIENDA						Total
	1. Jacal	2. Tugurio	3. Precaria	4. Popular	5. Media	6. Depto.	
0. Baño público	1	0	0	0	0	0	0
1. WC y jícara	0	0	2	28	10	1	41
2. WC y regadera	0	0	1	22	8	2	33
3. Letrina y jícara	0	0	52	136	34	10	212
4. Letrina y regadera	0	0	0	7	0	0	7
5. No es el caso	0	0	1	2	0	0	3
7. Jícara	0	5	22	98	8	1	134
8. Regadera	0	0	2	1	2	0	5
9. No se investigó	0	0	0	8	5	2	15
TOTAL:	1	5	60	302	67	16	451

FUENTE: Encuesta directa PEI-INAH-CECODES. 1979.

Cuadro 9

TIPO DE VIVIENDA Y DOTACIÓN DE DRENAJE EN CIUDADES PERDIDAS DE TIJUANA

Drenaje	TIPO DE VIVIENDA						Total
	1. Jacal	2. Tugurio	3. Precaria	4. Popular	5. Media	6. Depto.	
0. No se supo	1	0	0	0	0	0	0
1. Drenaje	0	0	5	72	20	2	99
2. Fosa séptica	0	0	19	52	10	4	85
3. Pozo ciego	0	5	20	80	12	1	118
4. Cielo abierto	0	0	9	18	6	5	38
5. 1 y 2	0	0	0	7	0	0	7
8. Otros casos	0	0	1	5	0	0	5
9. No se investigó	0	0	6	68	19	4	97
TOTAL:	1	5	60	302	67	16	451

FUENTE: Encuesta directa PEI-INAH-CECODES. 1979.

**Cuadro 10****TIPO DE VIVIENDA Y DOTACIÓN DE AGUA EN CIUDADES PERDIDAS DE TIJUANA**

Abasto de agua	TIPO DE VIVIENDA						Total
	1. <i>Iacal</i>	2. <i>Tugurio</i>	3. <i>Precaria</i>	4. <i>Popular</i>	5. <i>Media</i>	6. <i>Depo.</i>	
0. No se supo	1	0	0	0	0	0	1
1. Tiene hidratante en la casa	0	0	3	35	12	0	50
2. Hay hidratante en la calle	0	0	6	42	11	2	61
3. Se las llevan por pipas y la almacenan en tambos	0	5	48	220	44	14	331
4. Se las lleva un aguador y almacenan en tambos	0	0	2	3	0	0	5
5. No hay ningun servicio regular	0	0	1	0	0	0	1
7. Pozo	0	0	0	1	0	0	1
9. No se investigó	0	0	0	1	0	0	1
<b>TOTAL:</b>	<b>1</b>	<b>5</b>	<b>60</b>	<b>302</b>	<b>67</b>	<b>16</b>	<b>451</b>

FUENTE: Encuesta directa PEI-INAH-CECODES. 1979.

de la situación del medio ambiente de la citada ciudad a través del proyecto "Neighborhood Evaluation and Environmental Needs Survey" al cual se bautizó como "NEEDS". Dicho estudio demostró que había algunas vecindades en Douglas que tenían graves problemas de sobre población, calles en malas condiciones, ruido y serias fallas estructurales en sus viviendas. Los costos sociales del desarrollo en Douglas son mayores en las vecindades cuyos habitantes son de la clase baja y de ascendencia mexicana.

Como parte de ese proyecto, Downing y Villegas hicieron un análisis comparando la situación personal de los habitantes de dicha ciudad con observaciones recabadas por los ingenieros del Departamento de Salubridad Fronteriza. Al comparar los resultados del estudio del medio ambiente del hogar con la etnicidad, se encontró que los de origen mexicano vivían en Douglas en peores viviendas que los anglos. La estimación de las condiciones de vida fue hecha por los mismos dueños o inquilinos y por los ingenieros de salud pública (Tabla 1). Dichos datos confirmaron que la poca satisfacción expresada por los mexicanos era un reflejo de la condición de su medio ambiente.

Los investigadores también construyeron dos índices: uno sobre el grado de satisfacción personal de los ciudadanos de Douglas con su medio ambiente, y otro sobre sus actitudes y satisfacción con el medio ambiente vecinal. Dichos índices se compararon con los análisis efectuados por los ingenieros de salubridad pública en torno a las condiciones del medio ambiente de la casa. Resultó que los índices de satisfacción no estaban relacionados con la situación económica de los ciudadanos, sino con su etnicidad (Tabla 2). Igualmente, la satisfacción de los ciudadanos de este pueblo fronterizo con su medio ambiente personal era menor entre los de herencia mexicana que entre los habitantes anglosajones. Quiere decir que en Douglas los primeros son más afectados por problemas en su medio ambiente personal y vecinal que los anglosajones.

Para el caso de la frontera mexicana, los estudios realizados en Tijuana, Ciudad Juárez, Mexicali y Nogales por el equipo de investigadores del CECODES-PEI-INAH apuntan en la misma dirección. Sin embargo, en este caso el enfoque de los trabajos no distingue a la población por etnicidad (como sucede en el ejemplo, de Douglas, Arizona) sino que se toman en consideración factores tales como el ingreso, el tipo de empleo, la educación, etc.\*

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\* Consultese al respecto los informes preliminares de los proyectos: *Ciudades Perdidas y Marginados Urbanos* (CECODES-PEI-INAH) y *Trabajo y Migración en la Frontera Norte*, CECODES.

Tabla 1

**CONDICIÓN DE LA VIVIENDA Y ETNICIDAD EN DOUGLAS, ARIZONA**

		ETNICIDAD	
		Anglo	Herencia mexicana
Condición de la vivienda	Buena	34 (63%)	28 (28%)
	Mediana	11 (20%)	27 (27%)
	Pobre	9 (17%)	44 (45%)
TOTAL:		54 (100%)	99 N = 153 hogares (100%)

Tabla 2

**ETNICIDAD Y SATISFACCIÓN CON SU MEDIO AMBIENTE VECINAL EN DOUGLAS, ARIZONA**

		ETNICIDAD	
		Anglo	Herencia mexicana
Satisfacción con su medio ambiente vecinal	Alto	43 (80%)	51 (52%)
	Bajo	11 (20%)	48 (48%)
TOTAL:		54 (100%)	99 N = 153 hogares (100%)

FUENTE: Downing y Villegas (1975).

### LOS FACTORES POLÍTICOS

El impacto político más obvio de los problemas de la contaminación fronteriza ha sido la colaboración de varios acuerdos bilaterales entre México y los Estados Unidos. Negociaciones sobre problemas de recursos naturales fronterizos se han llevado a cabo por más de un siglo. Y desde que se firmó el Tratado de Aguas de 1944, varios otros acuerdos, memorandums y aun algunos más informales a nivel estatal y local se han suscrito para solucionar problemas del medio ambiente que afectan la frontera (United States Government 1944, 1973, 1978, 1978-9, 1980). Desde la perspectiva de comparar los acuerdos de control de contaminación a nivel internacional, son notables los de tipo bilateral firmados por México y Estados Unidos. Los dos países han empezado a poner en práctica mecanismos institucionales y técnicos para tratar el problema de la contaminación de sus fronteras. De todos ellos, el más importante a nivel institucional es la Comisión Internacional de Límites y Aguas. Ella, y sus precedentes comisiones binacionales, han logrado solucionar algunos delicados conflictos y problemas de límites y control de aguas.

En torno a los problemas de contaminación, el papel de la Comisión ha ido evolucionando. Mumme y Jamail (1980) anotan que sus éxitos más sobresalientes son en desacuerdos relacionados con límites fronterizos. El más reciente logro fue la solución de los conflictos surgidos por la contaminación del New River. (United States Government, 1980). y por la salinidad del Río Colorado (United States Government, 1973). Actualmente Estados Unidos construye en Arizona una planta desaladora de agua, situada a dos kilómetros de la frontera con México; en ella se tratan las aguas del Río Colorado, cuya salinidad afectó seriamente las tierras cultivables de los valles de Mexicali y San Luis en el lado mexicano. La planta comenzará a funcionar en 1986 y se piensa que con ella se pondrá fin a la salinidad mencionada. El problema fue resuelto mediante un tratado por medio del cual Estados Unidos se comprometió a entregar a México 1,850 millones de metros cúbicos de agua de buena calidad por medio del Río Colorado. Los daños que ocasionó esa salinidad en tierras de cultivo de México son incalculables.

También se ha establecido un mecanismo institucional para tratar algunos aspectos de saneamiento fronterizo (United States Government 1979). En el Acta número 261 se da mayor autoridad a la Comisión para resolver problemas de aguas contaminadas que afectan a poblaciones de ambos lados. Esto incluye mecanismos que permiten intercambio de información entre los dos países, asistencia técnica, y hasta construcción, mantenimiento y operación de proyectos binacionales. Y aunque el acta mencionada amplía los límites jurídicos de la Comisión respecto a los problemas de la contaminación, sus acciones se han limitado en su

mayor parte a una sola fuente: el agua. Esto demuestra una vez más la importancia de la selectividad en la decisión sobre qué es un problema. Los relacionados con la contaminación atmosférica y la de sólidos, al igual que los impactos socioeconómicos, han quedado fuera de estos mecanismos institucionales que lograron ya éxito al abordar conflictos anteriores en torno al agua.

Aparte de los acuerdos de dicha Comisión, también se firmó un memorándum de entendimiento entre la Subsecretaría de Mejoramiento del Ambiente de la Secretaría de Salubridad y Asistencia de México y la Agencia de Protección Ambiental de los Estados Unidos (EPA) para la "Cooperación en Problemas y Programas Ambientales a Través de la Frontera" (14 de junio de 1978, United States Government, 1978-9). Este es el primer memorándum que reconoce, a nivel oficial, el hecho de que los contaminantes tienen efectos humanos y globales. Al respecto, se afirma que:

En virtud de que la Subsecretaría del Mejoramiento del Ambiente de México (SMA), y la Agencia de Protección Ambiental de los Estados Unidos (EPA), tienen un interés común en relación a la protección y mejoramiento del *medio ambiente natural y humano* (subrayado nuestro) en sus respectivos países y compartiendo un interés común en cuanto a la protección ambiental en un sentido global y a lo largo de la frontera...

Dicha Acta establece un mecanismo institucional que permite actividades paralelas en relación a "cualquier asunto tendiente a la protección ambiental mediante un intercambio de información y de personal, y el establecimiento de planes de operación paralelos" entre los dos países. También se reconoce la autoridad de la Comisión sobre problemas sanitarios. Entre las actividades y proyectos autorizados, dicho acuerdo binacional incluye "Desarrollo de un sistema de advertencia temprana para informar a ambos Gobiernos en cuanto a problemas ambientales en potencia" (Artículo 8) y el "Desarrollo de programas para efectuar recolección, procesamiento, y establecimiento de mecanismos de intercambio de información de interés común." Desde el punto de vista institucional, la autorización para buscar solución a los problemas de impactos socioeconómicos originados por la contaminación, claramente son parte de este acuerdo.

Aunque oficialmente no se han dado a conocer los términos finales de entendimiento en octubre de 1981, representantes de la Subsecretaría del Mejoramiento del Ambiente de México, por una parte, y de la Agencia de Protección Ambiental (EPA) y de la Administración de Alimentos y Drogas (FDA) de Estados Unidos, por la otra, firmaron nuevos memorandums sobre diversos temas relacionados con la protección ambiental.

tal en ambos lados de la frontera. Dentro de estos esfuerzos, la delegación mexicana informó de los trabajos que se realizan en Ciudad Juárez, Tijuana, y otras ciudades de la frontera para instalar una red de monitoreo del aire, la cual servirá de control de la contaminación por partículas suspendidas en la atmósfera, especialmente ozono, monóxido de carbono y metales pesados.

Paradójicamente, al tiempo que se daban a conocer estas acciones, una reciente investigación elaborada en la Universidad Autónoma de Ciudad Juárez señala que a causa de la contaminación del agua y el aire de esa ciudad, casi las tres cuartas partes de los niños estudiados padecen afecciones del aparato digestivo; 66% del aparato respiratorio; 59% del sistema nervioso y 70% enfermedades de la piel. Por si fuera poco, nueve de cada diez niños menores de 9 años sufren de dolores articulares por la acumulación de metales pesados en los huesos. Partículas de dichos metales (especialmente plomo y cadmio) los arroja a la atmósfera la empresa transnacional Asarco, ubicada en El Paso, Texas. Cada año salen de la chimenea de esa empresa y caen sobre Ciudad Juárez, 313 toneladas de plomo, 157 de zinc y 3.1 de cadmio.

Otro tema que se discutió fue el del inadecuado manejo de plaguicidas así como su tránsito comercial a través de la frontera. Esto, referido especialmente a los productos cuya utilización no es permitida en los Estados Unidos. Se informó que los plaguicidas no autorizados tendrán tratamiento de sustancias potencialmente tóxicas y que la EPA informará con 4 semanas de anticipación a la Subsecretaría del Mejoramiento del Ambiente, sobre el tipo de agente químico, cantidad que se pretende exportar, así como puerto de embarque, para que se actúe en consecuencia.

Pero nada se dijo sobre la necesidad de aplicar restricciones serias al uso indiscriminado de dichos productos en el lado mexicano, asunto de gran trascendencia habida cuenta que muchos de ellos se hallan prohibidos en Estados Unidos y otros países por sus efectos negativos en el medio ambiente.

Aunque los canales oficiales de colaboración se hallan establecidos, han sido mínimas las actividades científicas binacionales sobre los efectos socioeconómicos que se dan por contaminación. Por el lado norteamericano, la administración actual ha reducido su atención a los problemas del medio ambiente en general, lo cual afecta la situación fronteriza. Aun cuando el énfasis de la presente administración norteamericana (y antes la de Carter) parece ir en favor de atender a la zona fronteriza, en septiembre de 1981 fue cancelada la Comisión Nacional de la Frontera del Sureste. Actualmente, no hay ningún proyecto binacional que esté cumpliendo lo establecido en el Acta 261 sobre temas tales como la protección del medio ambiente humano; el desarrollo de un sistema de advertencia previa para informar a ambos gobiernos en cuanto a

problemas ambientales en potencia al nivel de los impactos socioeconómicos de la contaminación; o un programa para recolectar, procesar y establecer mecanismos de intercambio de información sobre asuntos tan importantes para nuestras fronteras. Y aunque hay datos recopilados por varias instituciones en ambos lados sobre la contaminación social, no existe ninguna organización que esté analizándolos sistemáticamente y presente informes y propuestas de solución a las autoridades de los dos países. Con tales carencias, el problema de la contaminación y la sociedad es todavía un problema oculto.

#### **SELECTIVIDAD Y CONTROL DE LA CONTAMINACIÓN**

En los incisos anteriores hemos buscado demostrar que los factores de selectividad operan de tal manera que las causas y los efectos de la contaminación se distribuyen entre varios grupos económicos, sociales y políticos. La contaminación no afecta igualmente a la población total de la zona fronteriza, y hay una gran heterogeneidad entre los problemas de un lugar a otro, entre diversas clases sociales. Esta situación influye cualquier acción para controlar los efectos de la contaminación. Un ejemplo de esto se tiene una vez más en el caso de Ciudad Juárez. La zona noroeste de la población —conocida como La Carbonífera— está más cercana a la planta de la Asarco ubicada en El Paso. Precisamente en esa zona, el 92% de los niños que fueron recientemente objeto de estudio revelaron problemas digestivos, 84% afecciones nerviosas, 86% enfermedades del aparato respiratorio y 72% enfermedades de la piel. Allí es endémica la conjuntivitis y los niños muestran la mayor irritabilidad de la encontrada en toda la ciudad. Los estudios de diversas instituciones de investigación coinciden plenamente en que La Carbonífera, más que el resto del área, sufre del envenenamiento progresivo por dos contaminantes: plomo y cadmio, producidos por la Asarco. El primero daña seriamente el cerebro y es origen de otros graves problemas del ser humano. Y el segundo destruye los riñones, causa el enfisema pulmonar y catarro nasal crónico. ¿Existe alguna explicación de tipo productivo o económico que justifique un hecho como el anterior?

La selectividad frena la necesidad de realizar acciones urgentes, nacionales y hasta internacionales, por a lo menos, tres razones:

- a) En primer término, los efectos casi siempre se localizan en una sola área de la frontera (por ejemplo, un par de pueblos), lo que quiere decir que *no hay un problema de contaminación fronteriza sino varios problemas*.
- b) En segundo lugar, la contaminación solamente influye en una parte de la población del área afectada. Frecuentemente ni la

mayoría de los ciudadanos de un pueblo se preocupan por ella; sólo lo hacen cuando sufren directamente sus efectos negativos. Y finalmente,

- c) Muchos de los problemas no son urgentes en el sentido de requerir la atención inmediata de las autoridades. En política, los problemas inmediatos usualmente requieren mayor atención, mientras que los efectos socioeconómicos de la contaminación son de largo plazo, por lo que es más fácil que las autoridades eviten enfrentarlos de inmediato.

Por si fuera poco, los subsidios ocultos que suelen acompañar a la contaminación también impiden la acción política, dado que por lo general a las autoridades no les gusta cobrar a los grupos industriales que dominan en sus economías locales. Es notable que a pesar de todos los acuerdos y conferencias sobre este problema, la realidad de los costos y daños económicos de un lado y otro aún no hayan sido considerados seriamente.

La ausencia de programas, estudios y observaciones sobre este asunto a largo plazo empeoran la situación, pues la realidad de los impactos no siempre es bien clara desde el punto de vista científico. Sin embargo, la necesidad de investigaciones a largo plazo es evidente para ambos países; un primer intento de sistematización puede descansar en el esfuerzo conjunto, en la cooperación de instituciones científicas de México y Estados Unidos.

#### NOTA

Agradecemos la colaboración de Randy Hagan y Janet Breen, ayudantes de investigación de la Oficina de Estudios Étnicos de la Universidad de Arizona; de Milton Jamail y Carmen García, investigadores de la misma Universidad; y a Margarita Nolasco y María Luisa Acevedo, investigadoras del Instituto Nacional de Antropología e Historia y del Centro de Ecodesarrollo, de México.

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ment Policy.

# THE SOCIAL EFFECTS OF THE ECOLOGY AND DEVELOPMENT OF THE UNITED STATES-MEXICO BORDER

THOMAS WEAVER

First, this essay provides a theoretical framework for considering the social, economic, population, and political problems of the United States-Mexico border; second, a summary is presented of the economic and demographic development of the area; and finally, the most important regional social effects are surveyed.

The perspective provided here derives from the subdiscipline, socio-cultural anthropology, which uses as a take-off point the concepts of culture and adaptation, encompasses a holistic view (including various social and cultural linkages of a single topic, i. e., historical, demographic, economic, linguistic, etc.), is concerned with cross-cultural comparisons, and as a humanistic science tries to present the words and experiences of the persons who live in the society written about.

Writing an essay for a multidisciplinary audience presents one with the dilemma of having to balance a position taken from the perspective of one's own discipline and at the same time trying to break the limitations of that field by calling upon the theories and results of other sciences. In doing so I assume full responsibility for what may be an unclear interpretation or presentation of materials from other fields.

## TOWARDS A THEORY OF BORDERS

There are countless borders between nations and other political entities of the world with cities and relationships much like those present on the United States-Mexico border. Yet a theory for analyzing borders, or international boundaries has never been attempted. Such a theory would be useful for explaining the various kinds of activities, legal and illegal, which exist at and across international boundaries. Perhaps, borders have not been the subject of concern because they are usually

viewed as lines on a map representing where the political jurisdiction of one country ends and that of another begins, thus blurring other activities at or near the boundary. An explanation has not been made of why towns and cities on two sides of a border often have more in common with each other than they do with remote cities in their own nation. The theory presented here tries to deal with this commonality.

### *The United States-Mexico Border as an Area*

The theory of borders which will be presented is based on the analysis and integration of a number of issues and problems which relate to border, frontier, section, region, and culture. These concepts are briefly summarized, followed by a discussion showing how various resulting principles and conceptualizations constitute a theory of borders.

*Frontier and border.* One dictionary definition of "border" is "the line or frontier area separating political divisions or geographical regions; a boundary". In this instance line, frontier, and boundary are used synonymously. Persons in the United States refer to the United States-Mexico area as "the border", and seem to view the region as a line which separates two areas which are different in culture, language, and outlook. Mexicans refer to the area as a frontier (*frontera*). Frontier means something on the periphery, perhaps on the leading edge of a population movement. The use of two different, although synonymous, words for the same area may reflect different attitudes by citizens of the two nations.

Frontier has been used in a different sense by historians following the frontier theory propounded by Frederick Jackson Turner in 1893 which held that:

. . . the most unique feature of the American environment was an area of cheap land which constantly drew men westward. As they moved from civilized communities into the virgin forests on boundless prairies, the cake of custom was broken; there occurred in every pioneer settlement a reversion toward the primitive as settlers discarded the complex social controls, needed in areas where men lived elbow to elbow. Eventually each of these communities began the slow climb back toward civilization as population thickened, but in doing so customs and institutions that had been proven ill-suited to the environment were abandoned. The result was a gradual "Americanization" of both men and their customs.<sup>1</sup>

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<sup>1</sup> RAY ALLEN BILLINGTON, *The Far Western Frontier: 183—1860*. New York, Harper and Row, 1956. Quotes from Harper Torchback edition, 1962, pp. xiii-xviii.

Ideas from anthropology on cultural ecology and adaptation support Turner's assessment of the process undergone by frontiersmen as they move into a new cultural area and return to influence their old culture. Anthropologists would say that as Americans moved into new regions, such as the Far West and the Southwest, or recently, to the United States-Mexico border, that new adaptations were required for survival and successful exploitation of new natural and social environments. Once this was accomplished and population became more dense, an influence was felt in the institutions and values of the original culture which was now being impacted by those who had experienced the frontier. Thus, old institutions are changed as a result of new frontier experiences.

The adequacy of the thesis proposed by Turner to explain the influence of the frontier in developing American institutions and culture has been much discussed among historians in the intervening years. Most tend to adopt explanations of multiple causation and to see American culture as a product of many factors in addition to the influence of the frontier, such as having a European heritage, the impact of world economy and history, the presence of ethnic groups, and other related matters. Turner, of course, recognized many of these variables in his writings.

The United States border frontier and the Mexican border frontier have been of some concern to both countries, and there has been an effect on the institutions of both countries as feedback has occurred from people settling in the frontier region. For Mexico, for example, over the years the frontier region has been an area for political refuge from the internal regions during revolutionary turmoil. In subsequent years, as Mexico has witnessed one of the highest annual rates of population increase in the world, the northern frontier became a safety valve, which took pressure off the large urbanizing areas of Mexico City, Guadalajara, Puebla, and Monterrey. Indeed, through much of recent history Mexico has successively developed plans for agriculture and industry in the north to help relieve social pressures on the big cities, such as inadequate housing, poor food and water supplies, under- and unemployment, high rates of crime, congested traffic, and other social problems. The development of large irrigated farms in Sonora, Sinaloa, in the lower Colorado River, Tamaulipas, and along the Río Bravo was a concerted effort on the part of the Mexican government to provide more food and jobs for the nation's hungry and unemployed. The growth of the *Secretaría de Agricultura y Recursos Hídricos* into one of the most powerful ministries during this epoch was a result of the influence of the border frontier on the nation and the visualization that it might help to solve Mexico's perennial demographic and social problems. Similarly, the more recent development of the Border Industries Program has been a reaction to the same problem of poor distribution

of population in the urban areas and unemployment, but this time including unemployment and social problems in the border's urbanizing areas. These are but two examples of how the presence of the border and its special ecological characteristics have influenced Mexican institutions.

Although I have not examined extensively the influence of the United States border frontier on institutions and laws of the United States, some interesting suggestions can be made. The large population increases in the southwest United States border states occurred after the first and second World Wars. During these times there existed a need for increased food production and manufactured goods. Laws were passed which favored the agricultural development of the Southwest by creating dam and irrigation projects and providing subsidies for agricultural producers. The more rapid development of the United States side of the border, more attractive working conditions and the need for agricultural laborers, eventually lead to the movement of many Mexicans into the United States side of the region, either on a temporary or a permanent basis. The effect of undocumented workers on new migration laws and regulations constitutes a continuing influence of the Southwest border frontier on the institutions and laws of the nation.

Has this trend continued into the modern era? Are American and Mexican institutions still being affected by the border frontier experience? Today's "frontiersmen and frontier institutions" would be the border merchant, the border patrol, the customs agent, the "mordida", children begging on the bridges, undocumented workers, Mexican-Americans, and the American-Mexican in Mexico. What effect do they have on laws, regulations, and budgets, on size of bordertown police forces, on school curricula, on institutional health practices? Additional documentation could be mustered to demonstrate the influence of the border as frontier in changing institutions in both countries, but perhaps, sufficient evidence has been provided to indicate the value of Turner's frontier thesis.

Turner's thesis, however, leaves many unanswered questions about the frontier as an explanatory device for the border situation. The United States and Mexican frontiers are geographically propinquous, but politically separated areas; they are environmentally similar, but from the point of view engendered by the frontier thesis, they are two frontiers coming together at a common border. Frontier is an ethnocentric term used in this sense in that it refers to the leading edge of a single nation's civilization. The analytical problem with the use of this concept is that it may explain many incidents which occur on the frontier for the country in question, but it does not explain the effects of occurrences in the neighboring frontier. Such events would benefit from an analytical point of view which includes them in a single framework. In addition, the

concept of frontier does not deal with phenomena which overlap at the border. A border area is actually the place where the frontiers of two nations come together, intermingling aspects of two cultures, and we must be concerned with how these overlapping frontiers influence the institutions of both nations. The omission of a theory which encompasses such overlapping phenomenon is an error which comes from viewing an international border as a boundary, either in a cultural, economic, historical, or in any sense of the meaning of its being a clear demarcation between two entities, as being the end or beginning of something.

*Section and region.* Another perspective which can be taken of the United States-Mexico border is as an area with sectional interests, a notion also pioneered by the historian Turner, and a related idea current with modern economists and geographers-region. As with his frontier hypothesis, Turner's idea of section was motivated by an attempt to explain United States history. He felt that American history could be understood only in terms of the physiographic areas that comprised the country. These sections differed in soil, climate, and topography, and as a result, developed different economic profiles. Each section clashed with other sections in pushing its economic interests at the national political level. Billington's assessment of Turner's sectional theory follows:

Turner thought of these sections as comparable to the nations of Europe, each with its own races, leaders, economic activities, social attitudes, and cultural traditions; only the binding force of political parties, he felt, stopped them from flying apart to create a complex of independent countries. Within this framework the sections were constantly at swords-point; American history could best be told as a contest between the economic and social sections. They vied with each other on the floor of Congress where legislation was possible only through compromise and shifting alliances; Northeast and Midwest might combine to push through a high tariff bill, or Midwest and Southeast to achieve a lowering of land prices.<sup>2</sup>

Modern economists and geographers must have based some of their ideas of region on Turner's notion of section, first published in 1896. One can recognize his influence in the definition of region provided by Dickinson:

...a region is an area which is homogeneous in respect of some particular set of associated conditions, whether of the land or of

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<sup>2</sup> RAY ALLEN BILLINGTON, "Introduction: Frederick Jackson Turner—Universal Historian", *Frontier and Section: Selected Essays of Frederick Jackson Turner*. Englewood Cliffs., N. J., Prentice-Hall Inc., 1961, p. 8.

the people, such as industry, farming, the distribution of population, commerce, or the general sphere of influence of a city. Such an association is discovered to exist in terms of a single common factor or in terms of a variety of interdependent areal factors.<sup>3</sup>

Dickinson emphasizes the region as a natural area which forms a social unit with a common social structure. The diagnostic criteria of such a social unit may include:

. . . the intensity of economic intercourse, as reflected by the interchange of goods between one district and another, banking and credit relations, communications and accessibility; as well as common cultural elements-religious ties, traditions, the influence, past and present, of a dominant city, similarities of habits, standards, knowledge and skills.<sup>4</sup>

Other measurable criteria include such things as the "movement of vehicles . . . , the service areas of large mail-order houses . . . , the sphere of influence of educational institutions, as measured by the distribution of students' homes . . . , long-distance telephone communications, and the circulation of newspapers."<sup>5</sup>

In addition to the economic variables listed above other characteristics of a region as a conceptual unit are: (1) it is a spatial concept; (2) it usually indicates a subnational unit with a common identity, that is, it is usually intermediate between a national and a local area; (3) it may vary in size,<sup>6</sup> but must have finite boundaries so that data can be collected easily; however, it must be remembered that a homogeneously defined area with boundaries will tend to be more uniform at its core and less so at its periphery where it merges into adjacent regions; (4) units are useable for general resource planning and development purposes, such as in the case of the Tennessee Valley Authority (TVA); (5) it may include reorganizations of local administrative and governmental units into larger entities;<sup>7</sup> and (6) it allows for regionalization of such public services as health, water supply, and housing.<sup>8</sup>

<sup>3</sup> ROBERT E. DICKINSON, *City and Region: A Geographical Interpretation*. London, Routledge and Kegan, Ltd., 1964, p. 3.

<sup>4</sup> *Ibid.*, p. 6.

<sup>5</sup> *Ibid.*

<sup>6</sup> N. L. NICHOLSON and Z. W. SAMETZ, "Regions of Canada and the Regional Concept", in R. R. Krueger, F. O. Sargent, A. de Vos, N. Pearson (eds.), *Regional and Resource Planning in Canada*. Toronto, Holt Rinehart and Winston of Canada, Ltd., 1963, p. 6.

<sup>7</sup> DICKINSON, *City and . . .*, p. 6.

<sup>8</sup> *Ibid.*, p. 4.

A regional economist emphasizes the utilitarian aspects of the concept:

Common to all definitions is the idea of a geographical area constituting an entity, so that significant statements can be made about the area as a *whole*. Aggregation into regions is useful in connection with *description*, because it means that fewer separate numbers or other facts must be collected and handled... Similarly, aggregation is obviously economical in connection with *analysis* of data; and it is particularly important if there is a good deal of interdependence of units or activities within the area so that the whole really is different from the sum of its parts. Finally, and for similar reasons, aggregation is necessary for the formulation and implementation of public policies. From this standpoint at least, the most useful regional groupings are those that follow the boundaries of governmental jurisdiction.<sup>9</sup>

Economists recognize two types of regions: homogeneous and nodal. A nodal region operates around cities and is concerned with commuting and trading zones. Nodal region will be discussed below under central place theory. A homogeneous region is based on internal uniformity. An example is the winter wheat belt in the central United States in which all parts grow the same crop at the same time in the same way. Other examples include the various economic development and bureaucratic regions established by federal governmental agencies to manage field operations throughout the United States.<sup>10</sup> Various agencies thus identify a Southwest Region which includes the states which border Mexico, sometimes California, and occasionally also Oklahoma and Louisiana, which are not on the border. Likewise, Mexico identifies economic regions of *Frontera Norteña*, including Tamaulipas, Coahuila, Nuevo León, and Chihuahua, and *Pacífico Norte*, which includes Sinaloa, Sonora, the Baja Californias and sometimes Nayarit and others.

In the past, it has been useful to identify regions unilaterally on either side of the United States-Mexico border. However, when applied to border areas, the concepts of section and border do not explain adequately the nature of much overlapping activity. These shortcomings will become clear when we examine the application of central place theory to border areas. Later we argue that the notion of region must be expanded to include the binational area on both sides of political boundaries.

*Nodal region and central place theory.* The discussion of the functions of economic regions eventually leads to a discussion of the location of

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<sup>9</sup> EDGAR M. HOOVER, *An Introduction to Regional Economics*. New York, Alfred A. Knopf, 1971, p. 122.

<sup>10</sup> *Ibid.*, pp. 122-124.

central functions in nodal regions. Nodal regions evolve and operate around cities. Economists, geographers, and anthropologists have been utilizing central place theory to assist in the analyses of the city and its surrounding commuting and trading zone. The idea of central place theory may be explained as follows:

A chief function of country villages and towns is to be centers for their rural surroundings as well as mediators between local commerce and the outside world. Larger cities play a similar role with respect to systems of smaller villages and towns, which find in the larger places goods and services that the local country villages and towns are too small to supply. Thus, villages, towns, and cities serve in a structural relationship as *central places* for tributary regions.

Central place theory is fundamentally concerned with the patterns through which wholesale, retail, service, and administrative functions, plus market-oriented manufacturing, are provided to consuming populations. Thus, it can also be designated as the theory of urban trade and institutions or the theory of location of tertiary production.<sup>11</sup>

There is an extensive literature on central place theory and it has been tested and proved in many areas of the developed world and recently has been applied by anthropologists to underdeveloped regions.<sup>12</sup> Space limitations preclude a review of the applications of this theory. For the moment it suffices to list the following most commonly known uses: identifying types of central places, researching rank-size relationships, investigating hierarchical relationships, planning and locating business, industry, and service functions, determining market sizes, placing shopping centers, and finally, mathematical models have been developed to facilitate both empirical and applied work in these areas. Central place theory has not been applied to the analyses of towns along a political boundary as far as I know. The discussion of the application of central place theory to border areas will serve to identify some of the elements in a theory of borders.

*Bordertowns as central places.* People who live in border cities often view themselves as isolated from neighboring cities and as politically

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<sup>11</sup> BRIAN J. L. BERRY and CHAUNCEY D. HARRIS, "Central Place", *International Encyclopedia of the Social Sciences*. New York, The Macmillan Company and The Free Press, 1968, Vol. 1 and 2, p. 365.

<sup>12</sup> G. WILLIAM SKINNER, "Marketing and Social Structure in Rural China (Pt. 1)", *Journal of Asian Studies*, Vol. 24: 1 (1964), 3-43; Carol A. Smith, "Economics of Marketing Systems: Models from Economic Geography", *Annual Review of Anthropology*, 3 (1974), 167-201.

peripheral in their respective countries. A recent newspaper account reported such a situation for El Paso and Juárez. The article stated that there were no other major cities within 300 miles, making the two cities isolated economically and geographically and, therefore, interdependent. In fact, the cities are indeed physically isolated, and with a combined population of 1.5 million, they also form the second largest metropolitan area along the border. The director of the El Paso Chamber of Commerce was quoted: "The nearest city is too far for much trade to go on. There is relatively little monetary connection between Juárez and Mexico. Very little comes into Juárez from the balance of Mexico."<sup>13</sup>

The fallacy present in this view can be clarified through the use of central place theory. As has been stated the major premise behind this theory comes from visualizing major cities as places which are economically central to a hierarchically arranged network of smaller cities, towns, and hamlets. Each larger place provides goods and services not available in each smaller place, thus linking the whole region into an economically interdependent unit. This theory helps to explain many aspects of twin border cities, for example, why the nearest major cities to Juárez and El Paso are 250 or more miles away. This is what would be expected according to central place theory because each large city would be a major central place and part of a larger economic regional network.

A complete analysis is available only by knowing how the twin cities as central places provide necessary goods and services to all the other smaller places within their region. A major departure from standard central place thinking is that the trade and service region for the border cities includes parts of two economic regions. In short, the same economic analysis must be made for such border twin cities as would be made for the economic interrelationships of any two other linked cities, such as Minneapolis-St. Paul. Being on the border as they are, and serving different national economic regions, the two cities have a symbiotic relationship, both in complementary and supplementary senses, in that services available in one city complement or supplement and generally do not compete, with services available in the other place. This symbiotic relationship is necessary for the economic co-existence of two large cities located so close to each other. Examples of complementary and supplementary services include cheap labor, liquor and food, metal work, masonry, tile, crafts, quick divorces, inexpensive health and dental care, prostitution, and entertainment in night clubs from the Mexican city. The United States city provides employment, specialized health care, books, appliances, clothing and other retail goods, toys, automobile and

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<sup>13</sup> STEVE BREWER, "Abandoned together on the border, El Paso, Juárez depend on each other", *The Arizona Daily Star*, May 27, 1981.

truck tires, farm machinery, television sets, radios, calculators, and other manufactured goods.

An example of the symbiosis between the two cities was provided by a business consultant survey. The average Juárez family, with an income of less than \$ 270 a month, spent \$ 30 every week in El Paso, or almost \$ 90 million in 1978. The president of the El Paso Downtown Development Association estimated that 70 percent of the downtown customers are from Juárez. Additionally, a Chamber of Commerce survey in 1981 showed that more than 35 percent of El Paso's residents visit Juárez regularly and spend an average of \$ 17 per visit.<sup>14</sup>

Recognizing their economic interdependence, the two cities have made a joint concerted effort to attract tourist and convention business, with the El Paso Convention Bureau reporting an increase in tourism of 19 percent in 1980. Officials of the two cities also cooperate in keeping the traffic and money flowing between them by pressuring their respective governments to facilitate legislation conducive to maintaining the status quo. El Paso retailers, for example, lobbied for retention of temporary bridge-crossing permits which the United States government had planned to discontinue. Other evidences of mutual interdependence and symbiosis are the fact that sales clerks on both sides of the border are bilingual, signs and pricetags are often in dollars and pesos, and the two are interchangeable easily, almost being treated as if they were variants of the same monetary system.

The information abstracted from the newspaper article quoted and other sources documents the symbiotic relationship of the two border cities. It does not, however, demonstrate how the two cities together act as a central place which serves a much larger region encompassing parts of the interior of the two nations. From personal knowledge gained from travel into the interior of both countries along the United States-Mexico border, I would estimate that the services provided by the twin border cities of Juárez and El Paso, to focus on only a single such urban border constellation, extend as far as 250 or more miles in all directions along transportation routes. The next competing central places, which furnish similar services, are Albuquerque, New Mexico, about 330 miles to the north, and Chihuahua, Chihuahua, 233 miles to the south. In between lie countless villages, towns, and hamlets on either side of and along the border which depend on Juárez and El Paso for goods and services.

An additional example will serve to highlight the nature of the symbiosis between twin border cities and their relationships with the cities located in their own nations within the framework of central place theory. Patrons from Albuquerque are not likely to shop for goods or

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<sup>14</sup> *Ibid.*

services in El Paso because these goods and services are available in Albuquerque. Neither will El Pasoans go to Albuquerque for similar purposes and reasons. However, Albuquerqueans are likely to travel to Juárez for goods and services available there and not in El Paso (entertainment, bordellos, iron work, bricks, pottery, inexpensive body and paint work, dental services, etc.). Patrons from Juárez acquire American-made goods and services from El Paso rather than travel to Albuquerque, an additional 330 miles away. Potential customers from Chihuahua (233 miles), and perhaps as far away as Torreón (517 miles) will shop for American goods and services in El Paso, but will avoid Juárez because goods and services available there are also available at home.

*Culture and subculture.* The seminal ideas of anthropology have been the related notions of society and culture. Society is a broad term used to refer to a group of people who interact more with each other than they do with others. The basis and content of this interaction is their culture. Used thus, culture includes shared patterns of behavior, material goods, rules about behaving or making material goods, values about which goods or actions are better or worse, norms on how to behave and in what context, and how these things vary.<sup>15</sup>

Anthropologists have used the twin concepts of society and culture to describe such aboriginal people as the Hopi of northeastern Arizona. They have been characterized as a people numbering over 5,000 living in 15 villages with a way of life which is different from their neighbors, the Navajo and the Anglo-Americans who live in surrounding ranches and communities. Some of the distinctive cultural features of the Hopi are matrilineal descent, priesthoods and curing societies, ceremonies for rain and public welfare, kivas (underground ceremonial chambers for men), horticulture, and sheep raising and pick-up trucks in recent years. The concept of culture, thus, has been useful in describing and distinguishing the ways of life for various people studied by anthropologists.

As native people have become more scarce and travel to remote areas of the world more expensive, anthropologists have begun to work on applied problems in urban areas with non-indigenous groups. Because the urban area is so large it has been difficult to describe the whole region within a single conceptual context. Therefore, we have leaned heavily on the notion of subculture, which is a variant or portion of a culture shared by a subsegment of the larger society, such as an occupational or an ethnic group. In this way anthropologists have described the way of life of dockworkers, tramps, Mexican-Americans,

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<sup>15</sup> E. ADAMSON HOEBEL and THOMAS WEAVER, *Anthropology and the Human Experience*. 5th Edition, New York, McGraw-Hill Book Company, 1979, pp. 278-295.

urban Indians, and Hare Krishna religious groups. In this same connection a useful concept has been biculturalism, which refers to individuals who have more than one set of cultural ideas and operate with rules from different cultures, perhaps at different times. These last two concepts are crucial to the presentation of the theory of borders which follows.

#### A THEORY OF BORDERS

*A summary of related concepts.* Having examined briefly the concepts which have contributed to our thinking, a summary of these ideas can serve as a prelude to a theory of borders. One of the first premises one must remember when working with border areas is that the notion of border as a boundary which separates two sets of social and cultural phenomena is grossly inadequate. A border is usually looked at as a boundary or line which separates politically and legally two or more political entities such as nations, states, counties, or tribes. These political entities are governed by different legal and judicial institutions and codes of behavior. Permission is usually required to cross or to conduct business or activity across these boundaries. The major problem is that too much focus on "border" as a dividing line obscures the overlapping activities which occur on both sides of the border.

The concept of frontier has helped historians explain how less developed areas (frontiers) as recipients of migrants from the same country have an influence on the institutions and laws of the "home base" culture. How this happens has been described in a very general manner in the previous section. The Southwest United States and *Frontera Norteña* areas as frontiers have had clear influences on the laws and activities of each country, respectively. The problem with the concept is that it may explain singular phenomenon for each country, but does not consider overlapping activities. A border area is actually a place where the frontiers of two societies come together, intermingling aspects of the two cultures. Frontier as used by Turner and others does not account for how happenings in one country affect laws and institutions in the society across the border. A framework which encompasses the area on both sides of a political boundary and which considers the frontiers of both countries as part of the same analytical framework, would contribute much to understanding international relations which are affected by border activities.

The related concepts of section and region have been used to isolate for analytical purposes those aspects of a unit with an artificially delimited area which have more in common within, than outside of, the established limits of the area. Thus, a region may have such elements in common as economic activities, social attitudes, ethnic groups, ad-

ministrative functions, health facilities, water supplies, political problems, and population characteristics. Previously the idea of region has been used to refer to areas within national boundaries. It is suggested that the conceptual framework of region lends itself well to a border area which encompasses territory on both sides of a political boundary. Used in this manner, a United States-Mexico border region would be identified to include parts of both countries within the same analytical scope. The following are some of the characteristics which may be used to identify the boundaries of such a border cultural region: (1) *common economic features* such as merchandise and businesses designed to serve the "other side" of the border in a symbiotic, or bi-modal manner described previously; (2) *similar governmental and administrative agencies* which regulate commercial and human traffic and activities across and at the border, such as border patrols, customs, drug and arms control, taxation, documented and undocumented workers, oversize and understaffed local agencies, such as city and county police, health, hospital, employment, welfare, and education, etc.; (3) *social problems endemic to the region*, such as unusual crimes due to the presence of drugs and smuggling activities, the lack or laxness of applicability of the laws of one nation to the population of the other, overcrowding, housing problems, and inadequate water and sanitation facilities resulting from rapid urbanization; (4) *other specialized activities and institutions*, such as mordida (informal and illegal pay-offs), arms smuggling, trade in contraband goods not available or taxed in one or the other country, such as truck tires, farm equipment, radios, electronic equipment, calculators, etc., and children begging on the bridges or streets; (5) *unique cultural practices*, such as widespread bilingualism, and trade in a (unofficially) common monetary system (in the sense that money from either country is readily and easily useable in the other country).

Economic features of a border cultural region are best explained through the special application of central place theory to border towns. Central place theory has not been utilized to analyze the central place functions of cities and towns lying along a political boundary. It is suggested that the trade and service hinterland of border towns and cities includes areas in the country on the other side of the border. Twin border towns and cities, that is those lying directly across international boundaries from each other, have symbiotic relationships in the sense that services available in one place complement or supplement the goods and services available in the other. Examples of such symbiotic goods and services available in Mexican cities include: cheap labor, liquor, food, metal work, masonry, tile, brick, crafts, quick divorces, inexpensive health and dental care, furniture, prostitution, and night club entertainment. Complementary or supplementary goods and services available in the United States cities include: employment, American-made

groceries and products, appliances, books, clothing, toys, automobile and truck tires, farm equipment, television sets, radios, calculators and other manufactured goods, educational facilities, health specialists not available in Mexico along the border, such as treatment for cancer, the handicapped, and other rare diseases.

In sum, we are suggesting a cultural view of the United States-Mexico border region which takes the border as the center of an area which encompasses a portion of the political domains of the two bounded societies; it is a separate society, in a sense, with a unique culture of its own, made up of elements which overlap and come from the two mother cultures. The culture of this subsociety would include those characteristics listed above as elements of a border cultural region.

*A schematic presentation—border culture.* To visualize the theory of borders described so far, it might be profitable to examine the border schematically as if it were a flat plane having horizontal and vertical dimensions. This is depicted in Diagram 1.

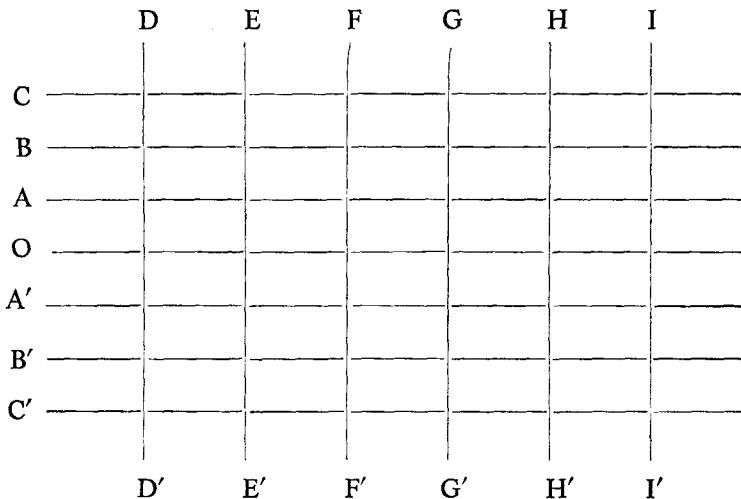


Diagram 1

As one moves away from the center line (marked O) which represents the United States-Mexico border, one will encounter less of what can be identified as border culture. For example, the towns and cities located between the horizontal lines A and A' exhibit more of the characteristics

of border culture than do those towns and cities located between horizontal lines B and C and between B' and C'. To illustrate this point with real places, Douglas, Arizona (an A town) and Agua Prieta an (A' town) exhibit more border culture than do Flagstaff, Arizona (a C town) or Parral, Chihuahua (a C' town). In the same manner one encounters less Mexican or American influence as one moves farther away from the border, north and south, as the case may be.

*A schematic presentation—border subculture.* Because a border may be very long, as in the case of the United States-Mexico border, other differences exist along the border, such as economic, political, climatic, etc. In this case one must be prepared to identify subregions or subcultures. Anyone who has traveled along the United States side of the United States-Mexico border, and compared so-called Mexican food (sometimes called Spanish food) will know that differences exist, not only in taste, but in the regional dishes available. A taco is not just a taco; the California variety is different from the Texas taco, and *chimichangas* are found only in Arizona. Other examples will be provided later, but perhaps it is well to point out now that there are differences among the United States border states of Texas, New Mexico, Arizona, and California in laws, attitudes, dialects, racism, economy, and amount of Spanish spoken. Likewise, subregional differences are found among the northern Mexican states. This is not to suggest that the subcultural differences will necessarily coincide with state or other political boundaries; geography, climate, local ecology, and culture may cut across political or administrative entities.

The idea of border subculture can be illustrated by referring back to schematic presentation made regarding border culture (see Diagram 1). The vertical lines D-D', E-E', F-F', G-G', H-H', I-I' in the diagram represent the limits of border subcultural (subregional) differences. Thus, towns and cities located in the areas delimited by lines D-D' and E-E' differ somewhat from those located in the areas bounded by lines F-F' and G-G'. They differ in subtle ways such as the aforementioned ethnic foods, language dialects, and the characteristics of migrants.

Other examples of subcultural, or subregional differences include the names of informal savings and investment associations found among Mexicans and Mexican-Americans.<sup>16</sup> Names and other characteristics of these associations vary according to the vertical divisions indicated above. The name for these associations is *cundina* from Sinaloa to Sonora, Baja California, and California, and in the border towns of Mexicali, Tijuana, Ensenada, San Diego, National City, Chula Vista, and Los Angeles

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<sup>16</sup> CARLOS VÉLEZ, *Bonds of Mutual Trust: The Cultural System of Rotating Credit Associations among Urban Mexicans and Chicanos*. 1982, New Brunswick, N. J., Rutgers University Press, forthcoming.

(represented by the boxes created between vertical lines D-D' and E-E'); the name is *tanda* for this association from the central states of Mexico to Chihuahua, Nuevo León and Texas (represented by boxes created between vertical lines E-E' and F-F'). It can be seen from this example, that one of the variables which affects this similarity of subcultural factors is related to migration corridors (see discussion below). This model, thus, becomes applicable to the analyses of the characteristics of illegal migrants to the United States from Mexico, a point which will be spelled out more clearly in a later section of this essay.

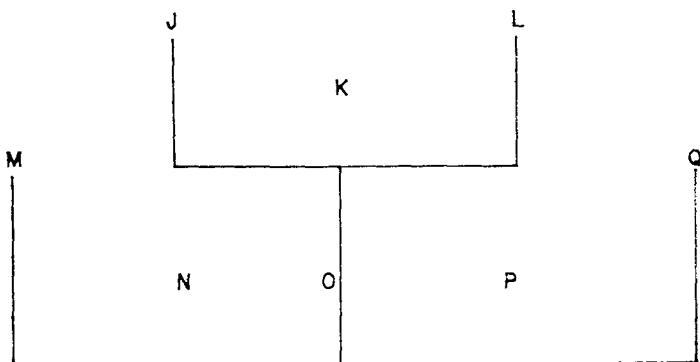
Looking at these subcultural variables on the United States side of the border only, one can see the differences among Mexican-American groups living in Texas, New Mexico, Arizona, and California. These differences are related to historical factors, such as the order of settlement (New Mexico, followed by California, Texas and Arizona), and also to the regional origin of the ancestors of these people in Mexico and Spain. It hardly seems necessary to reiterate that this observation is also related to the corridors of migration referred to previously (and to be discussed further). Perhaps the Mexican-American subcultural difference is most clearly demonstrated by comparing the activities of Mexican-American political action groups. The origin, leadership, goals, and activity of activist groups are clearly different in Texas, Colorado, New Mexico, Arizona, and California.<sup>17</sup>

*Border culture and biculturalism.* When one focuses on border towns as exemplars of what we have been calling border culture, one is struck by their apparent bilingual-bicultural configuration. Border towns on both sides of the United States-Mexico border are largely bilingual, with Americans, Mexicans, and Mexican-Americans speaking English and Spanish separately or together in the same sentences or conversations. Culture includes, but is much more, than language. Culture includes norms, values, behavior, institutions, roles, and material elements. On one hand, we are concerned with those things which are shared by persons who have a border culture, and on the other hand, with those elements which are shared by persons belonging to the same national culture. In this connection border culture is the result of the Mexicanization of the United States side of the border and the Americanization of the Mexican side, making the United States side more like the Mexican side and the Mexican side more like the United States side.

Border culture as we have defined it, thus, is a superstructure which overlaps two cultures and "straddles" the border which divides them. This may be depicted schematically as follows:

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<sup>17</sup> TONY CASTRO, *Chicano Power: The Emergence of Mexican America*. New York, Saturday Review, 1974; Abelardo B. Delgado, *The Chicano Movement: Some Not Too Objective Observations*. Denver, Totinem, 1971.



**DIAGRAM 2.**

N and P represent cultural elements and institutions of two societies separated by line O, which is the border. N could be the United States and P the Mexican-national cultures. K represents border culture and includes all those elements which are shared by persons who also live in both societies, N and P. Vertical lines M, O, Q represent the boundaries of societies N and P. Vertical lines J and L represent the boundaries of a border culture, K.

The point of biculturalism and border culture may be clarified by using the hypothetical example of a border merchant living in a United States border town. Those activities are border culture which relate to his dealings with persons found within the border subsociety. Likewise activities are national culture which relate to interrelations with persons from his national society. One example has been referred to previously in the section on "Border towns as central places" as bi-modal economy. By bi-modal economy we mean the dual or symbiotic nature of border economy; each border town has an economy oriented to serve its native consumers and a second to serve consumers from across the border. Thus, our hypothetical border merchant has two sets of clients—native United States clients and clients from the other side. He behaves according to two different cultural codes for each set of clients. Examples of national culture would be attending Parent Teacher Association meetings, voting in local and national elections, attending church, going to Little League games with his son, and escorting his daughter down the aisle at her wedding. Examples of border culture would be dealing with customs and immigration officials and patrols, paying mordida, the

whole complex of activity involving the transportation, hiring, and use of undocumented workers, illegal transactions such as prostitution, the drug traffic, and the movement of contraband, such as guns, to avoid taxation or legal sanctions.

Research on bilingual-bicultural persons and ethnic identities has influenced the theory of borders presented here. For example, from the point of view of an Anglo, a Mexican-American is a person who belongs to or participates in a Mexican culture, at least part of the time; the rest of the time the Mexican-American is working at being an American. The reverse view is held by a Mexican with regard to this same Mexican-American. Considering this same set of facts from the point of view of border theory, i. e., that the boundary is really the center of another social set and another cultural universe, leads to the observation that a bilingual-bicultural person is at the same time part of, and separate from the Anglo and Mexican societies, but, in addition, represents an entirely new subsociety; that is, the bilingual-bicultural person at times participates in a separate subsociety. Those who are in it have more in common with each other than they do with either Mexicans or Americans. The crucial point is that being a Mexican-American requires a special worldview, which has been developed through a special adaptive process.

A parallel argument can be made for border culture, its bimodality, and its boundaries. Any person living near the border is in a sense bicultural, participating in a national and a border culture. It is a special adaptation in the same manner that a bilingual-bicultural individual has one set of behavioral and cognitive modes which operate while dealing with persons in the dominant culture (read national culture for border theory) and another set utilized when dealing with the ethnic culture (read border culture for border theory).

*Boundaries of border culture.* Having previously dismissed the value of borders as real boundaries, it would seem that the theory proposed presents the dilemma of answering the question of where a border culture ends. Certainly the best example or depiction of a border culture is at or near the border itself. It ends, in short, where border cultural characteristics end. Dallas or Albuquerque can be said to share some characteristics with a United States-Mexico border town such as El Paso. But do they represent the boundary of the border culture? Why not Denver or Chicago? In fact, Denver and Chicago, and nowadays, Toronto, too, reflect United States-Mexico border culture to some degree. It may be that social scientists in the past have placed too much emphasis on the strict limits of social phenomena. Social phenomena involve social relations and social relations exist where people transact and negotiate in cultural terms characteristic of a particular society. Following this line of thought, we could conclude that when we speak of the boundaries

of border culture and subculture we are referring to something akin to the complex outline of the leaves and branches of a tree, as it sways in the wind and changes with the season, and we try to define where its moving boundaries integrate and separate from the air and sky. The problem with setting boundaries is part of the dualist trap that has linguistically imprisoned thinkers developed in western civilization. Things are up or down, right or left, right or wrong; a border is the end and beginning of something; it is or is not. We never consider that there are other forms of thought, other ways of considering, for example, that the line which separates societies can be the center rather than the edge.

#### **THE ECOLOGY AND DEVELOPMENT OF THE UNITED STATES-MEXICO BORDER REGION**

When anthropologists speak of ecology they refer to the relationship which humans have to their environment. Cultural ecologists study how groups organize to maximize the use of the natural resources available, how they adapt to them, the type of organizations they form to cope with the exigencies of the natural as well as the social environments, the decision-making processes for the allocation and distribution of the natural and social resources, and how these all change through time in a continuous adaptive process.<sup>18</sup> Cultural ecology also refers to the types of subsistence adaptations made by humans to their environment. These types include hunting and gathering (foraging), fishing, pastoralism, horticulturalism, agriculturalism, industrialism, and urbanism. In this paper, we will describe the demography, urbanism, and economic development of the United States-Mexico border region, and the institutions and behaviors developed which are unique to border culture.

Border culture is a special adaptation which begins with the establishment of a boundary between two adjacent societies or nations. As such the border culture will reflect the nature of the changing political, social, and economic relationships between the two societies represented. Thus, it may be, as has been the case with the United States-Mexico border, but also true of all borders, that at the beginning the border may be sparsely settled, settlements small in size, and the border culture relatively simple in terms of having few institutions designed to regulate the exchange of economic goods and services, or the movement of population into and across the border region. A special characteristic of the United

<sup>18</sup> ROBERT MCC. NETTING, *The Ecological Approach in Cultural Anthropology*. Addison-Wesley Publishing Co., 1971; Julian Steward, *Theory of Cultural Change*. Urbana, University of Illinois Press, 1955; Yehudi Cohen (ed.), *Man in Adaptation*. Chicago, Aldine, 1968.

United States-Mexico border is its symbiotic development. One aspect of this has been discussed in the section on border towns as central places. Another example is the development of the United States border agricultural sector. The need for cheap labor encouraged the movement of Mexicans into north Mexico, and the border cities on the Mexican side became places where Mexicans waited for the next agricultural cycle. With time, the secondary retail and service economic sectors developed to support the increased populations.

#### *The Economic Development of the Border Region*

The information which follows in the next two sections of this essay has not been completely or systematically developed to support the theory presented in the first part. I have only been able to sketch broadly the processes and dynamics of the theory along the United States-Mexico border. One way to circumvent the lack of detail is to show in table form some of the developments and reactions along the United States-Mexico border which will be explored in more detail in another paper. The general outline of this train of thought is summarized in the table which follows:

**Table 1**  
**INTERRELATIONS OF ECOLOGY AND DEVELOPMENT**  
**ON THE UNITED STATES-MEXICO BORDER**

<i>United States development</i>	<i>Mexican development</i>
1. Isolation 1848-1878	Isolation
2. 1880s: Construction of railroad to United States border	→ Mexican railroad to north, 1890s; easier migration to north for Mexicans; higher wages in the north; highest growth rates of north cities in all Mexico; new settlements in north
3. Poor business in United States border town; United States citizens lease property in Mexico	← 1885-1890: Establishment of Free Trade Zone along Mexican border; business booms in Mexican border towns →
4. 1890s: River diversion and appropriation of waters	→ Abandonment of farms in Juárez area
5. Booming of El Paso and other border business	← 1905: Abolition of Free Trade Zone

Table 1 (*Continues*)

<i>United States development</i>	<i>Mexican development</i>
6. 1900-1910: Mining and industry established	
7. 1910-1916: Construction of Butte Dam lead to increased farming in the middle Río Grande Valley	→ Employment of farm and mine laborers in the United States; new ejidal lands settled
8. Immigrants: creation of slums in border towns; local business boom	← Mexican Revolution, 1910-1920; poverty, lack of food, etc. Loss of economic growth; critical conditions
9. 1912-1933: Prohibition era	→ Establishment of bars, gambling, casinos, prostitution, night clubs; development of tourism
10. 1925-1935: Agricultural production decreases; depression; bank failures	→ Forced and voluntary repatriation of Mexicans; decline in tourism
11. 1940-1964: World War II; United States agricultural development; border military build-up; 1942-1964: bracero program	→ Border towns boom again; employment of 4 million farm workers in the United States
12. 1948, 1954, 1976: purchasing value of dollar improves in Mexico; but sales drop in United States	← 1948, 1954, 1976: devaluation of Mexican peso;
13. Negligible impact	← 1954: National Border Movement; buy Mexican
14. 1964: abolition of Bracero Program	→ Entrance of over 4.7 million illegal workers to United States
15. (?)	1961: PRONAF (Programa Nacional Fronterizo); investments in border industries
16. (?)	1971: abolishment of "Quickie Divorce Law", loss of income to border towns

**Table 1 (Continues)**

<i>United States development</i>	<i>Mexican development</i>
17. (?)	1971: Artículos Gancho: border merchants can purchase some United States goods for resale
18. Cheap labor; increased profits ← more industry to United States border	1965: Mexico Border Industrialization Program

The economic development of both sides of the United States-Mexico border is clearly related to the following major factors: 1) the regulation of the movement of people and products into and across the area, 2) the flow of tourists southward, 3) the flourishing of tourism, 4) the development of agriculture and mining in the United States, especially in the Southwest region, 5) the transportation of vegetables north from the agricultural regions of northern Mexico, 6) the flow in both directions of contraband (weapons, retail goods, appliances, farming equipment), 7) the illegal traffic in drugs, 8) the movement of undocumented workers to the United States, 9) the bracero movement, 10) the development of the retail industry in United States border towns, and 11) the establishment of the Mexico Border Industries Program. Only two of these topics are discussed—the bracero movement and the Border Industries Program.

One of the most important recent phases of economic growth of the border area has been the agricultural development of the United States Southwest after World War II. This was primarily due to the increased need for food during and after World War II and the result of increased mechanization and irrigation of newly developed lands. The second important recent phase was a result of a slow down in the agricultural sector, leading to a cut off of the bracero program and starting up of Mexico's Border Industries Program.

#### *Agriculture and the Bracero Movement*

Up until 1964, when the program was terminated, workers moved in a steady stream from the interior of Mexico to its northern border and into the United States. These workers provided the cheap labor which was needed by the United States agricultural sector which was converting the Southwest region into a burgeoning, increasingly mechanized agricultural industry. The movement of Mexicans across the border

was legal in some years and illegal in others, depending on changing politics and economic circumstances in the United States. During the World War years, both I and II, there was a great demand for laborers, so laws were laxly enforced or non-existent. It has been estimated by Samora that over 1 million workers came to the United States from Mexico annually from 1941 to 1945.

Samora (1971) has shown a clear correlation between a decrease in braceros in the United States and an increase in illegal entrants. This is depicted in an updated chart from Samora (see Diagram 3). In 1964, the last year of the Bracero program, 185,000 workers worked in the United States, and in the same year only 13,000 undocumented workers were expelled. The following year, only 3,000 braceros were allowed to enter to help save failing crops, and an estimated 185,000 undocumented workers came to the United States. The implications of these facts seem evident.

#### *The Border Industrialization Program*

Before 1965, workers had been drawn to the northern Mexican border because of the need for cheap labor in the Southwest United States agricultural regions. When the Bracero program was cut off in 1964, and it appeared to Mexican observers that the United States had little intention of re-establishing the program because of widespread criticism by United States citizens, Mexico jumped into the breach to help the many persons found in its northern cities who were unemployed and living under poverty conditions. These people had either been returned by United States immigration authorities to the Mexican border towns, or were persons who had come north and were waiting to cross the border for employment. Even though unemployment had been high in prior years, mirroring the general conditions in Mexico and the United States, 1964 was an extremely bad year. In Nogales, Sonora, for example, it was estimated that 50 percent of the work force was unemployed.

The Mexican government responded to these problems by establishing its Border Industrialization Program (*Programa de Industrialización Fronteriza*).<sup>19</sup> With this act Mexico hoped to compete with the Far Eastern countries, where United States industrialists had been locating assembly plants to take advantage of cheap labor supply. The program permitted the United States and other countries to operate wholly owned assembly plants in a twelve-mile wide free zone starting at the border. Statutes also allowed duty-free importation of components to be assembled in Mexico and duty-free exportation after assembly. Temporary location

<sup>19</sup> DONALD W. BAERRESEN, *The Border Industrialization Program of Mexico*. Lexington, Mass., Heath Lexington Books, 1971.

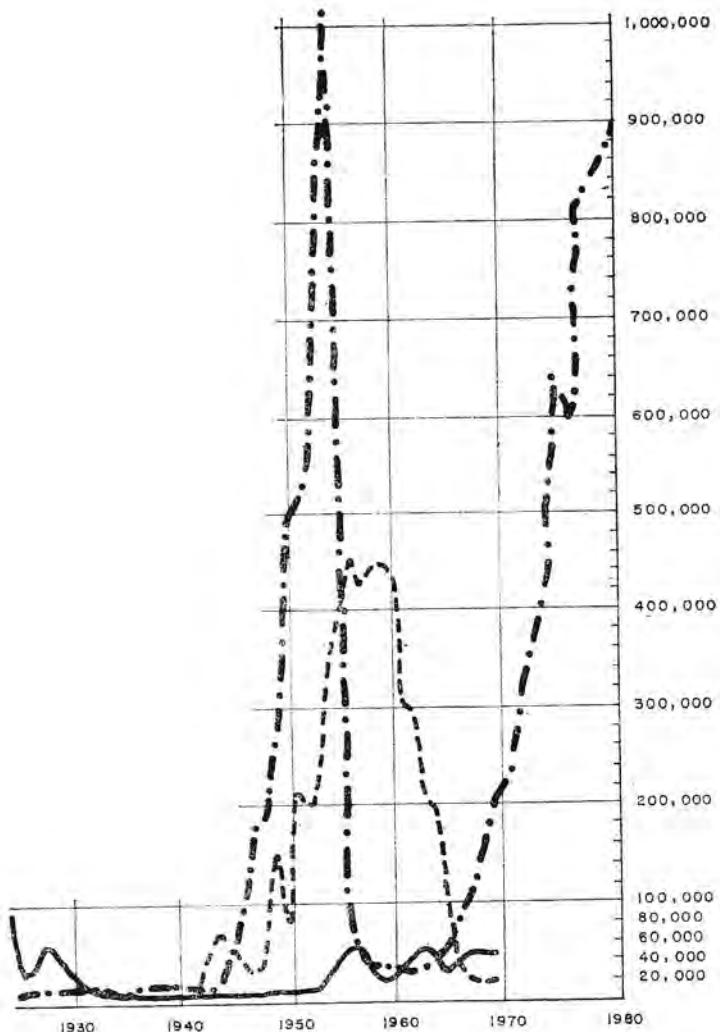


DIAGRAM 3.

Mexican Migration

(Updated from Samora, 1971)

of the products was necessary in order to qualify for duty-free status and the products could not be sold in Mexico.

Work in the Mexican plant is the assembly part of a manufacturing operation which may take place in a twin plant on the United States side, although, sometimes the process in the United States plant may be a finishing operation. United States government tariffs have favored participation of United States industry in this program by only requiring duty on the value added to the product by Mexican labor and overhead. There is also a small "informal tax" required by Mexican officials colloquially referred to as a *mordida* (bite). Participation has also been encouraged by promotion from United States border town chambers of commerce, not only because the twin plant in the United States generates a limited manufacturing employment, but because of the substantial earnings made by American border retailers from purchases made by Mexicans.

Two changes were made in 1972 by Mexico in the statutes regulating the Border Industries Program. First, the plants which had been restricted to locating in the twelve-mile free zone, now can locate anywhere in the country, except Mexico City, Guadalajara, Monterrey, and other highly industrialized areas. These new plants must also locate in existing industrial parks, a provision designed to promote the development of smaller border towns such as Naco, Sonoita, and San Luis in Sonora, for example, and to other parts of the country. The second main change is that the decree now permits sale in Mexico of the products produced, provided duty is paid on the components imported and that the item not compete with Mexican products.

Although requirement to disperse plants to the interior of Mexico hurt American industry with increased transportation costs, this has probably been offset by the higher costs they would pay in Far Eastern countries, by the sale of some of its products in a new market, and by the new pools of cheap labor they can tap. In the intervening years the fortune of the twin plants concept has reflected rising wages in Mexico and the United States, with world recessions and inflations, and other political and economic matters which have affected relations between the two countries.

In 1970 there were 219 companies operating in the program with factories located in 13 cities and towns in Mexico along its northern border. The estimated number of employees was 2-3,000 for each plant, and the minimum daily wage ranged from \$ 2.38 in Piedras Negras, Coahuila, to \$ 3.68 in Tijuana, Baja California.<sup>20</sup> By 1973 México had passed Taiwan and Hong Kong in the number of assembly plants. In 1974, products assembled in Mexico represented 14 percent of all of

<sup>20</sup> *Ibid.*

Mexico's exports. This is especially significant when we consider that the Mexican export value is only calculated on the value added in Mexico and not on the value of the total product. Nevertheless, this amounted to \$ 444 million in 1974.<sup>21</sup> In 1980 United States companies continue to profit from the lower wages paid for Mexican labor at the Mexican plant, about \$ 1.34 an hour minimum. A 1980 report shows there are about 620 plants in Mexico employing about 120,000 workers.<sup>22</sup> The United States twin plant also gains from lower wages paid in the United States border cities compared to wages paid elsewhere in the United States; the minimum hourly wage in Arizona, for example, is \$ 3.25.

#### *Recent Urbanization of the Border Region*

From the point of view of the social sciences the ecology and development of any region reflects changes in population. In the instance of the United States-Mexico border the most outstanding ecological phenomenon has been the steady urbanization of both sides of this international boundary. In the pages that follow we shall provide a brief overview before discussing the institutional changes which follow in the next section.

In 1970, one sixth of each nation's population lived in states on the United States-Mexico border. In Mexico this represented 7.8 million of a total population of 48 million. In the United States almost 34 million of over 203 million people lived along the Mexican border. In comparison figures for 1910 indicated that 11 percent of 15 million for Mexico and 7 percent of 92 million for the United States lived along the United States-Mexico border. The figures for 1970 are rather astounding when one considers that the border states for both countries include the largest and next to largest states by area in each country (Chihuahua and Texas); the total area covered by the border states represents respectively 41 percent (6 states) of all of Mexico and 18 percent (4 states) of all the area for the United States.

What have been the patterns of movement in the present century with respect to the border? What has caused such a large movement of people to a common border? What have been some of the social effects of this movement?

#### *Urbanization of the Northern Mexican States*

Using a definition of urban places as those communities with 2,500 or more persons, we find that 29 percent of Mexico's population was

<sup>21</sup> "United States Firms Leave Mexico as Costs Rise and Product Demand Falls", *The Arizona Republic*, May 25, 1975.

<sup>22</sup> BOB SVEJCARA, "Twin-plant idea grows in Sonora", *The Arizona Daily Star* October 31, 1980.

urban in 1910, 33 percent in 1930, 50 percent in 1960, and 58.7 percent in 1970.<sup>23</sup> Urban population in some northern states has exceeded the number living in rural areas since 1921 in Coahuila (50 percent), since 1950 in Nuevo León (56 percent), and in Tamaulipas (53 percent). One reason cited for the early urbanization of the Mexican population was a desire to seek refuge during the revolutionary war years. Some cities have grown as a result of the increased demand for agricultural labor in the large northern farms now being irrigated. This includes cities in Baja California, Sonora, and Tamaulipas. Mexicali, for example, increased its population 58 times between 1921 and 1970. Ciudad Obregón grew from a railroad stop of 38 persons in 1910 to become the largest city in Sonora in 1960 and continuing in 1970 to a population of 181,972, second only to Hermosillo by a few thousand persons. El Mante, Tamaulipas grew not only because of the lands irrigated from the Río Bravo and its tributaries, but also due to its sugar mill industry.

Tourism has been another factor contributing to the urbanization of the Mexican states in the northern border. Tijuana, perhaps, presents the most outstanding example of this phenomenon, having grown 431 times its size between 1910 and 1970. Juárez grew 41 times its size during the same period, comparable to Acapulco which increased by 40 times its 1910 population. González Navarro emphasizes the significance of this change when he notes with regard to the growth of Tijuana and Mexicali that:

...in 1920 they imported bread, washed their clothes... most public employees resided in the United States (those from Mexicali in Caléxico and those from Tijuana mostly in San Diego). Abelardo Rodríguez remedied the situation by encouraging the construction of homes on the Mexican side and by prohibiting employees to live in California; thanks to which by the 30s Mexicali had developed more than Caléxico.<sup>24</sup>

As a result of a visit by President Cárdenas in 1939, the Mexican government initiated the construction of a railroad line and the creation of a trade free zone. Mexicali has continued to grow at a more rapid rate than Caléxico, so that by 1970 the former city had increased to 390,411 persons whereas the United States city numbered only 10,625 inhabitants. The same, however, did not occur in the case of Tijuana and San Diego; the first growing to a population of 335,125 and the second to 697,027,

<sup>23</sup> Much of the demographic information on Mexico is summarized from Moisés González Navarro, *Población y Sociedad en México (1900-1970)* México, Universidad Nacional Autónoma de México, 1974, Vol. I, pp. 71-77.

<sup>24</sup> *Ibid.*, p. 74.

a figure which does not include the metropolitan area of the latter, which exceeds 2.8 million.

Another city picked for special attention by González Navarro is Tampico in Tamaulipas. Although this city is somewhat to the south of the border along the Gulf coast and is a seaport as well, it still comes under the influence of border culture. Unlike other northern cities, this Mexican town owed its early growth to the oil industry, so that between 1900-1919 it had grown from 12,500 to nearly 60,000, and by 1970 to 185,059 persons. Ciudad Madero is another city in Tamaulipas with a similar origin in the petroleum industry, but with a slightly less dramatic growth. As part of the Tampico-Ciudad Madero metropolitan area, it grew from a city of 25,704 in 1930 to four times its size of 101,059 in 1970, bringing the total metropolitan population to 286,141.

Two other urban places which are located away from the border are Torreón in Coahuila and its twin-city Gómez Palacio in Durango. Torreón grew 7.3 times its 1910 population of 34,271 to 250,524 in 1970, whereas Gómez Palacio grew more than eight times its 1910 size of 15,997 to 132,631 in 1970. This provided a 1970 combined metropolitan population for both cities of 383,155.

Another metropolitan cluster in Nuevo León had a similar dramatic increase during this period. Monterrey-Guadalupe-San Nicolás de la Garza y Garza García increased from 81,789 persons in 1910 to a 1970 population of 1,141,638, of which 858,107 lived in Monterrey alone. Industrialization has been the major factor contributing to the growth of these last two named metropolitan areas, being most important in Monterrey, and with the development of agriculture taking an equally important position in the case of Torreón.

In referring to the years 1940-1970 as the second period of Mexican urbanization, Moisés González Navarro summarizes some of the concomitant problems which have arisen:

...there has been a displacement of an agricultural population to an industrial one, but since the level of the nation's industrialization has not integrated this human mass into the secondary activities of industry and the tertiary ones of service, the problem of idleness in the rural area has been converted to an urban one of underemployment. This proletariat mass with origins in the rural area transplanted to the large cities, having helped industry by providing a large reserve of cheap labor, has become adapted partly and slowly to modern industrial work. Demographic "explosion", a rural exodus and industrialization, in short, have been concurrent drives to the urbanization of the second period.<sup>25</sup>

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<sup>25</sup> *Ibid.*, p. 77.

### *Migration Corridors*

Many persons who have moved to the northern boundary are really part of a larger migration cycle, moving from rural to urban areas or as commuters and temporary seasonal workers, coming to work in northern Mexico and the United States for one or two seasons and never returning again. Others return again and again when times are tough, or when more money is needed for an operation or a pick-up truck. Some, after years of coming to the same place, become familiar with their home away from home, and stay longer each time, begin to think about this place more and more and about central Mexico less and less, and decide to have their family join them for a permanent stay—to cast their lot in a new land.

*Where they come from; where they go.* People coming to the northern Mexican states and the United States traditionally have come from the rural areas of the central plateau, and in recent years the more northern central and border states have contributed the largest numbers. A series of corridors exist which funnel persons to specific regions in the north and, occasionally, on to the United States. The number of states contributing migrants has also increased in recent years. In a study of migrants in the 1920s Gamio<sup>26</sup> suggested that 60 percent of the persons coming to the United States left the central plateau states of Michoacán, Guanajuato, and Jalisco plus the northern border state of Nuevo León. In 1971, Samora<sup>27</sup> stated that 73 percent of the migrants coming to the United States continued to leave the states identified by Gamio and from other states ranging farther north—San Luis Potosí, Zacatecas, Durango, and Chihuahua. Recent studies show that the largest number of migrants to the United States, both legal and illegal, move relatively short distances from the border states. Although there is no direct evidence, it must be assumed that these same states contribute population to the northern Mexican states and use the same corridors.

The identification of migration corridors is important for understanding the origin of migrants and for assessing regional variations in border culture. To understand migration corridors one must be aware of geographic features such as mountain ranges and the transportation routes which they influence. Northern Mexico is broken into three areas by the two mountain ranges, the Sierra Madre Oriental (Eastern) and the Sierra Madre Occidental (Western), which rise from four to five

<sup>26</sup> MANUEL GAMIO, *Mexican Immigration to the United States: A Study of Human Migration and Adjustment*. New York, Dover Publications Inc. First published in 1930 by the University of Chicago Press.

<sup>27</sup> JULIÁN SAMORA, *Los Mojados: The Wetback Story*. Notre Dame, Ind., University of Notre Dame Press, 1971.

thousand feet in the north to over 19,000 feet above sea level where they meet in the south, near Mexico City. The three areas thus created are the eastern and western coastal plains, and the central plateau. The lines of transportation, highways and railroad lines, generally follow the three areas of flatter terrain predominantly in a north-south direction. The western range presents an almost impassable barrier, except in a few places. The physical features of northern Mexico, thus, tend to create corridors which funnel migrants northward. Migrants move from as far south as Michoacán and Oaxaca up the west coast, populating every state up the coast and into California and the Colorado River valley in Arizona and as far north as the Canadian border. The lower central plateau states (Jalisco, Guanajuato, San Luis Potosí, Zacatecas, and Durango) channel persons in one fork to the east Mexican coast states of Tamaulipas and Nuevo León and into the lower part of the lower Río Grande Valley in Texas, and in a second central fork to Chihuahua, Coahuila and El Paso, New Mexico, Colorado, and other northern United States states. The northern Mexican border states which are now providing the largest numbers of workers to the United States are Chihuahua, Tamaulipas, Nuevo León, and Sonora. Coahuila and the two Baja Californias are not often mentioned as places of origin, perhaps because of the small proportion of migrants furnished from these more sparsely populated states.<sup>28</sup>

#### RECENT SOCIAL EFFECTS

Although an historical overview was presented in the previous section on the general overall ecology and development of the United States-Mexico region, because of space limitations the discussion in this part deals only with the social effects of the past decade on northern Mexico and United States border towns and cities.

##### *Social Effects on Northern Mexican Border Towns and Cities*

Demographers reported an increased urban growth for the northern Mexico states at least since the 1950s, an urban growth that has accelerated as time has passed, until at the present the border region is one of the more urbanized areas in Mexico. With this urbanization have come all of the problems to an area which was not politically or

<sup>28</sup> Texas Advisory Committee to the United States Commission on Civil Rights, *Sin Papeles: The Undocumented in Texas*. Washington, D. C., United States Government Printing Office, January 1980, pp. 41, 13-14; Roy Flores and Gilbert Cárdenas, "A Study of the Demographic and Employment Characteristics of Undocumented Aliens", quoted in study above.

technically ready to accommodate this rapid growth. The resultant problems became more clearly defined with the beginning of the Borders Industries Program in 1964.

One of Mexico's objectives in creating the Border Industries Program must have been to stem the tide of migrants to the four principal industrial centers: Puebla, Monterrey, Guadalajara, and Mexico City. Whether or not it had been an intended objective, it had the effect of channeling people to the northern border. The fear of some observers is that the Mexico-United States Border Industrialization Program has been too successful in attracting workers from the interior of Mexico and that the border towns on the Mexican side have become staging areas for illegal immigration to the United States. In a recently completed study, Seligson and Williams conclude this is not true.<sup>29</sup> They maintain that the Border Program has only attracted people to the border in recent years. Only 15 percent of the people interviewed had ever migrated to the United States, either legally or illegally, *but about 61 percent would like to move to this country*. Although their study found little two-stage immigration from Mexico's interior to northern border towns, and on to the United States, projections can be made from this and other studies that stated desires can be a factor in future immigration.

Nogales, Sonora, can serve as a case in point regarding the social effects of the Border Industrialization Program.<sup>30</sup> Between 1970 and 1974 the Nogales, Sonora population increased from 53,000 to over 100,000 persons; the population was mostly attracted by promises of work in the 50 manufacturing plants. The population explosion placed heavy demands on the city in terms of severe shortages of water, housing, inadequate transportation and medical facilities. People found they had to live in cardboard shacks without water, electricity, plumbing, and jobs were not always available as expected. Many had to seek alternate employment as gardeners and in other menial jobs. Opportunists made what appeared to be extravagant profits by selling water at 56 cents for a small container. The sewer system only met 35 percent of the population's needs, leading to the less sanitary installation of private septic tanks and out door latrines. Social Security clinics were severely understaffed with only 29 doctors, 12 interns, 58 nurses, 78 vocational nurses, 8 laboratory technicians, one operating room, and one delivery room for the clinic's 34,000 patients.

The world recession in 1975 and an increase in wages in Mexico led to the closing of many plants along the border. It was estimated in

<sup>29</sup> "Study finds migrants, border plants not tied", *The Arizona Daily Star*, March 17, 1980.

<sup>30</sup> ALEX DREHSLER, "Industry Boom a Hardship in Sonora Town", *The Arizona Daily Star*, May 5, 1975.

1973 that 25 percent of the 80,000 people previously employed in the total border industries program were unemployed. In Nogales, alone, employment dropped from 11,000 to 8,000 in 1974. Border policemen felt that this unemployment had led to a higher crime rate in United States border towns.

In summary, the social effect of the establishment of the Border Industries Program was to increase the number of people moving to Mexico's northern border states. Obviously, the Mexican border towns were not prepared for this increase in population. It placed pressure on poorly developed housing, public utilities, sewers, streets, social service agencies, schools, and practically every other area of life. There has been much speculation, but little study, on the effects of the predominantly female employment in the Border Industries Program. Many suggest that it constituted a disruptive force on the ideal, male-oriented, Mexican family. Additionally, the border towns were not prepared for the United States recessions in the 1970s, which threw people out of work for intermittent periods, creating greater burdens for the Mexican economy and social service sectors. This has been described in the case of Nogales, Sonora, but the situation was the same in the border towns across the northern frontier.

#### *Social Effects on United States Border Towns and Cities*

The historical dimensions of the development and urbanization of the United States side of the border has been presented in the previous part of this paper. Here we shall be concerned only with effects of the last ten years in education, health, employment and wages, public services, and crime.

*Education.* The massive influx of legal and illegal residents has caused the following problems for local school districts along the United States-Mexico border: severely overcrowded classrooms, lowered tax revenues, sub-standard schools, and staffing deficiencies because of a short supply of bilingual teachers. Other problems are unpredictable enrollments and irregular attendance because students leave with their families in search of other work at the end of each season.

The Gadsden Elementary School near San Luis, Arizona, can serve as a case in point. Only four miles from the Mexican border, nine out of ten children are Mexican aliens in the school, according to a study completed in 1979 by the Organization of United States Border Cities.<sup>31</sup> The school normally holds 500 children, but 750 students were expected for the fall semester. The teachers complain that the students are not in

<sup>31</sup> JOHN M. CREWDSON, "Border schools feel crush of immigration", *The Arizona Daily Star*, August 26, 1979.

school long enough and have difficulty learning English. It requires two and one-half hours to feed the students in the small cafeteria. "There are no gymnasiums, shops, or home economic facilities, and the classrooms are filled to 115 percent of capacity."<sup>32</sup> The problem is complicated by several factors, among which is the fact that there is little revenue-producing industry in United States border towns and the district has reached its limit in issuing debt bonds. There are federal funds available to help educate the children of migrant workers for purchasing facilities and equipment, but the money must be used strictly for migrant children. The principal at the Gadsden school complained "if we show a film with a migrant-funded projector, we're not going to take our five non-migrant kids out of the class".<sup>33</sup> The school has not utilized the program since 1970. The district cannot raise sufficient revenues to build more classrooms or furnish additional equipment. Only 50 of its 1,700 residents are registered voters—mostly older citizens without children in elementary school; most Mexican residents are not citizens.

Similar complaints have been echoed by school administrators in the 59 school districts in California, Arizona, New Mexico, and Texas, according to the same study, which found that the number of resident alien children is growing at a faster rate in these schools than the student population in general.

*Health.* United States citizens without health insurance or money are eligible for social security, medicare, or indigent care at many local hospitals. Non-citizens are asked to pay an estimated cost in advance, but are usually admitted whether they pay or not. One Arizona hospital has written off \$ 5 million in uncollectible patient debts in fiscal year 1979-80. About 15 percent of this debt, or \$ 750,000 is attributed to Mexican citizens, both legal and illegal entrants to the United States. Another Tucson, Arizona, hospital reported losses estimated at about one-half this amount. A hospital administrator explained that these bad debts are passed on to other consumers in higher rates.<sup>34</sup>

This problem is most clearly exemplified by Santa Cruz, an Arizona county which has Mexico as its immediate southern neighbor. In 1978 the county overran its health budget at mid-fiscal year. Although the county is the smallest in the state, it had the highest percentage of indigents, the highest rate of unemployment, and no county hospital. The indigent health caseload numbered 1,700 persons, or about 10 percent of the county population. Ninety percent of the 1,700 were citizens of Mexico. The high percentage of Mexicans on the indigent health rolls

<sup>32</sup> *Ibid.*

<sup>33</sup> *Ibid.*

<sup>34</sup> MARY POWERS, "Medical Maze: Who cares... and who pays?", *The Arizona Daily Star*, September 28, 1980.

results from the more than 3,000 Mexicans who live in the county legally as workers, the so-called green-card holders. Green-card holders are persons who have sponsors in the United States, who may employ them but must guarantee that they do not become public charges. County officials complain that the law is not enforced and that green-card holders and their relatives are eligible for indigent health care and other welfare services as a result of legal residence in the county. Although the state requires that counties pay for indigent health care, they do not allow more than a ten percent annual over-run increase in their budget. Skyrocketing health-care costs have not allowed the beleaguered counties to keep up with increasing expenses,<sup>35</sup> and some are being managed by out-of-state health management corporations or are in the process of bankruptcy. The Douglas Hospital in Cochise County, Arizona has recently been taken over by the United States government for not repaying a loan.

The facts reported above are not substantiated in general by a March 1979 report by DHEW on unpaid medical costs and undocumented aliens.<sup>36</sup> The major findings of the study were:

1. Of the nine hospitals included in the study only three were concerned with the problem, two were not interested, and four were aware of losses, but did not consider them serious.
2. Of the nine hospitals, three did not want to discourage undocumented persons from seeking services because of the public health hazards which would result.
3. Undocumented persons frequently use community-based outreach facilities where a nominal fee is charged. This was considered a good trade-off by administrators because of the public health gains.
4. One hospital was concerned with the possible loss of profitable Mexican patients, some of whom may have been undocumented persons.
5. The hospitals do not have systematic methods for determining alien status, placing more emphasis on whether they are county residents, and none of the hospitals had exact figures on losses due to the treatment of undocumented persons.
6. In order of frequency of hospital facilities used were emergency room, maternity, and traumatic accident services.

<sup>35</sup> SAM STINSON, "Health care funds for poor run out in Santa Cruz", *The Arizona Daily Star*, January 25, 1978.

<sup>36</sup> GRACE S. FLORES, *Unpaid Medical Costs and Undocumented Aliens*. Washington, D. C., Department of Health, Education and Welfare (Office of Special Concerns, Office of the Assistant Secretary for Planning and Evaluation), March 1979.

7. Three hospitals reported that undocumented persons had as good or nearly as good paying records as self-paying United States citizen patients.
8. The largest estimated loss was by Los Angeles County Hospital in 1976 for from \$40 to \$61 million, or 8 to 12 percent of the hospital's budget. Bexar Hospital in San Antonio estimated that about 3 percent of its total budget was lost in services to undocumented persons.

The DHEW study provides a rosier, if not a more tolerable picture with acceptable trade-offs, than found in southern Arizona. However, a critique of this study must include the inadequacy of the sampling framework. How many hospitals are located along the border? How well do the small county and local hospitals fare without the larger clientele and state and federal support systems of a Los Angeles County Hospital? How much of the public health concern can the smaller hospitals and local districts assume with their smaller tax bases? These and other questions have been left unanswered by the DHEW study.

*Employment and wages.* There are two opposing views as to whether undocumented workers in the United States together with a cheap labor supply available across the border lower wages to the disadvantage of American workers. Various farmworker groups maintain that foreign workers are willing to work for lower wages, without the fringe benefits and working conditions available to United States workers, and that the general result is broad scale unemployment for American farmworkers and other occupations along the United States-Mexico border. Many services are available at considerably lower prices on the Mexican side. These services include everything from tile and masonry work to painting and upholstery of automobiles, to such specialized work as rebuilding of automotive transmissions and motors. Informal interviews held by this investigator in El Paso, Texas, indicated that the hiring of Mexican workers from Juárez lowered wages among lathe operators, for example, forcing one interviewee to seek a lower paying job. He maintained that the availability of workers willing to work for lower wages has discouraged the formation and strengthening of unions along the border.

The second point of view is reflected by employers who claim they cannot be competitive with foreign clothing and farming industries by paying the higher wages demanded by American workers, and that Mexican workers are better and more reliable workers. American workers counter that Mexican workers will tolerate working conditions, and treatment by supervisors and employers, that are not acceptable to American workers. Regarding the necessity for alien workers, the most interesting statement comes from the INS director in the Los Angeles

office:<sup>37</sup> "There is not a business or industry of any type here that does not have undocumented workers... If we were to pick up every illegal alien in this area, we would close down not just 90 percent of the restaurants and car washes but many of the light industries." Population statistics tend to support in a surprising manner the continuation of such a policy. The demographic curve in the United States during the next decade may reflect a major labor shortage for American business and industry. A prediction is made that there will be a decline in the number of young people between the ages of 16 and 24, who usually take lesser skilled jobs when they first enter the job market. This shortage of workers could form a vacuum which will spur further illegal and legal migration.<sup>38</sup>

In 1979 the United States Labor Department proposed an increase in minimum wages for foreigners hired temporarily as farm workers by replacing standards set by states with a national wage rate. Farm-worker groups claim this would help lower unemployment rates and raise wages for United States workers by eliminating Mexican workers as competitors on the United States labor market. The current minimum hourly wage, which ranges from \$ 2.90 in Rhode Island to \$ 3.79 in Florida, would be raised by the proposed legislation to \$ 4.11 in 1979 and \$ 4.51 in 1980. The increase would apply to the 14 states which participate in the government program allowing the legal use of foreign farm labor when employers can prove there is no interest among United States citizens in filling the jobs. States participating in this program are Arizona, Colorado, Connecticut, Florida, Maine, Maryland, Massachusetts, New Hampshire, New York, Rhode Island, Texas, Vermont, Virginia, and West Virginia.<sup>39</sup> The unemployment rate in the United States could be reduced to less than 4 percent if it were not for the presence of undocumented workers, according to the past Secretary of Labor, Ray Marshall. He disagrees with the argument that undocumented workers are helpful to the economy because they take jobs that American citizens are not able or willing to perform.<sup>40</sup>

*Public services.* The general conclusion of many studies, contrary to an often expressed view, is that undocumented workers do not constitute a drain on public services, and in fact contribute much to the local economy by paying taxes and purchasing goods and services.

<sup>37</sup> JOHN M. CREWDSON, "Illegal aliens bypass farms to bump citizens from industrial jobs", *The Arizona Daily Star*, November 10, 1980.

<sup>38</sup> ROBERT REINHOLD, "A maturing workforce comes of age", *New York Times*, January 6, 1980.

<sup>39</sup> "New farm-pay rate proposal for aliens", *The Arizona Daily Star*, March 30, 1980.

<sup>40</sup> "Carter aide sees impact of aliens on joblessness", *New York Times*, December 3, 1979. Associated Press dispatch from Los Angeles, December 2, 1979.

What happens when the problem is actually investigated? A study conducted of records between March 12 and July 15, 1975, in San Diego County found that only ten out of 5,894 aliens in the study sample were on welfare rolls.<sup>41</sup> A study conducted in Texas found that 30 percent of 600 interviewees had contributed to social security and 27 percent had paid income taxes. None had received social security benefits. Nearly 40 percent of the sample had been unemployed at some time but less than 10 percent sought unemployment assistance, and none received unemployment insurance. In El Paso, 8 percent and in Edinburg-McAllen, 1 percent of the sample sought employment through the Texas Employment Commission. Four of 600 persons applied under the Aid to Families with Dependent Children Program. Less than 10 percent tried to get Social Security Assistance or food stamps. Only 38 persons applied for assistance from Migrant Health Services.<sup>42</sup>

*Crime.* In a study completed in 1974 Weaver and Downing found that law enforcement agencies, school and health facilities in Douglas, Arizona, were overtaxed as a result of having to deal with larger client loads than would be the case for cities not located on the border.<sup>43</sup> A ten percent random sample was made of 21,000 arrest records between 1961 and 1973, and a 20 percent sample of juvenile delinquency records for the years 1971-1973. More than half (54 percent) of the arrests involved residents and 25.5 percent were of Mexican citizens, most of whom were residents of the town across the border. Slightly more than half (51.7 percent) of the juveniles contacted by police were Mexican citizens. More than half of the arrests of Mexicans were for illegal entry into the United States (57.7 percent). Twenty percent of arrests of Mexicans were for shoplifting, 15 percent for alcohol related matters, and 11 percent concerned driver's license irregularities. Mexican residents were responsible for 78 percent of all shoplifting offenses, 53 percent of all burglaries, and 33 percent of all border-related offenses. By contrast they were responsible for only 14 percent of drug arrests, 9 percent of alcohol-related arrests, and 7 percent of all assaults. Sixty percent of those arrested were unemployed; 57 percent were single. All burglaries and 77 percent of all shoplifting were committed by unemployed persons.

Unlike the information uncovered in the Douglas study by Weaver and Downing, a research project in the Lower Río Grande reported

<sup>41</sup> Human Resources Agency, *A Study of Impact of Illegal Aliens on the County of San Diego in Specific Socioeconomic Areas*, p. 41 as cited in Flores, *Unpaid Medical Costs...*, p. 10.

<sup>42</sup> Texas Advisory Committee, *op. cit.*, p. 41.

<sup>43</sup> THOMAS WEAVER and THEODORE DOWNING (eds.), *The Douglas Report: The Community Context of Housing and Social Problems*. Tucson, Arizona, Bureau of Ethnic Research, University of Arizona, 1975.

much less crime.<sup>44</sup> Over 90 percent (91.6) of the respondents reported not having been arrested for reasons other than their undocumented status. About 6 percent of the El Paso sample and 3 percent of the Edinburg-McAllen sample admitted to such arrests. However, these results may have been an artifact of the study population and research procedures. Unlike the Douglas study which sampled official police records, the Lower Río Grande study depended upon information reported by respondents, thus depicting a self-reported law-abiding population.

The social effects of the ecology and development of the United States-Mexico border region are summarized in the following table.

**Table 2**  
**SOCIAL EFFECTS OF THE ECOLOGY AND DEVELOPMENT  
 OF THE UNITED STATES-MEXICO BORDER REGION**

Mexico side	United States side
+ safety valve for national unemployment	+ increased employment in service industries
+ increased wages	+ increased retail trade and profits
- intermittent periods of high unemployment in border towns	+ slight increase in industrial employment
- urban sprawl	± effects on public services
- inadequate housing, water, electricity, sewers	+ cheap labor supply allowing continued United States world competition
- development of poor and squatter housing	- increased crime, delinquency
- increased crime	- increased health load
- overload of health, educational facilities	- increased educational load
- family disruption as a result of high young female employment in border industries	- lowering of United States wages
- urban poverty	- discouragement of unions

<sup>44</sup> Texas Advisory Committee, *op. cit.*, p. 44.

## COMENTARIO

VÍCTOR CARLOS GARCÍA MORENO

I. Hemos afirmado en otra parte<sup>1</sup> que la investigación acerca de los problemas que se presentan en la región fronteriza México-Estados Unidos, en gran parte originados por la vecindad geográfica con el hegemón del norte, no ha recibido la suficiente atención que se merece por parte de las autoridades gubernamentales mexicanas, en tanto que en el mundo oficial y académico norteamericano ha sido objeto de un gran despliegue.

Hemos afirmado también que sería un craso error, metodológico y de contenido, desubicar el estudio de la frontera de su marco general como son las relaciones bilaterales entre ambos países. Más grave aún sería tratar de estudiar a la frontera sin reconocer la relación de dependencia existente de México con respecto a la economía de los Estados Unidos.

Comprendemos, por consiguiente, que la gama de problemas que se engendran en dicha región fronteriza puede, y de hecho lo es, ser muy vasta: indocumentados, maquiladoras, causas criminógenas (incluido el narcotráfico), turismo fronterizo, límites y aguas, comercio intrarregional, problemas pesqueros y de delimitación de los espacios marinos, colaboración judicial internacional, incluyendo la extradición fronteriza, etc.

Si tratásemos de resumir, muy apretadamente, las causas del subdesarrollo o sus aristas más relevantes con relación a la economía y sociedad mexicanas, no tendríamos temor en afirmar que se debe a factores estructurales internos, pero también a su enorme dependencia con respecto a la economía norteamericana. Dentro de los primeros está, en primer lugar, la quiebra evidente del llamado modelo de desarrollo mexicano.

<sup>1</sup> VÍCTOR CARLOS GARCÍA MORENO, "Marco económico y social de la industria maquiladora en la frontera México-estadounidense", en Varios autores, *Relaciones México-Estados Unidos*. México, UNAM, 1981, p. 209-231.

Reubicándonos en el tema, México comparte una frontera común con los Estados Unidos de más de 3,597 kilómetros, sin contar las fronteras marinas, comprendiendo, del lado mexicano, 36 municipios (Bustamante afirma que 34), repartidos en seis entidades federativas: Baja California norte, Sonora, Chihuahua, Coahuila, Nuevo León y Tamaulipas con una población superior a los tres millones. Por el lado norteamericano se colinda con los estados de California, Arizona, Nuevo México y Texas abarcando 24 condados con más de 3.5 millones de habitantes. Como se podrá observar, en dicha región fronteriza se presenta una interacción internacional bastante intensa de un conglomerado de 7 millones, aproximadamente, de personas que pertenecen a dos países con economías, políticas y culturas muy diferentes, lo que, no obstante, produce patrones de comportamiento específicos. Hemos reiterado que la frontera México-Estados Unidos es un magnífico laboratorio para estudiar las relaciones de la dependencia.<sup>2</sup>

Dos son los principales problemas que adolece la región fronteriza del norte de México: su acelerado crecimiento demográfico, muy por arriba de la media nacional, y su enorme desvinculación (geográfica, económica, cultural, etc.) con respecto al resto del país. La frontera del norte de México depende, en muchos aspectos, esencialmente en el económico, de los Estados Unidos.

Reconocemos que problemas de la región fronteriza no son privativos del lado mexicano, sino que tienen su contraparte del lado norteamericano, y, quizás, también en una forma crítica. Las ciudades fronterizas del lado norteamericano (San Diego, Caléxico, Nogales, Brownsville, McAllen, Laredo y, en menor grado, El Paso) dependen bastante de México: sus actividades están dirigidas mayormente hacia el mercado mexicano, y el sector de la agricultura también depende de la mano de obra mexicana. Siendo, como es, que dichas ciudades carecen de un desarrollo industrial significativo, se puede afirmar que ellas también se hallan, hasta cierto punto, desvinculadas económicamente del resto de los Estados Unidos. Pero consideramos que la desvinculación cultural es aún más significativa no sólo en las ciudades fronterizas, sino en las 300 millas de la línea fronteriza, más del 50% de la población mexicana o de origen mexicano en una generación más

<sup>2</sup> Véase GARCÍA MORENO, "Marco económico...", p. 216; "La economía fronteriza del norte de México", en Roque González Salazar (comp.), *La frontera del norte: integración y desarrollo*. México, El Colegio de México, 1981, p. 261-277; Víctor Carlos García Moreno, "El impacto de las empresas transnacionales en el México contemporáneo y la frontera norte", *Revista de la Facultad de Derecho de México*, Tomo XXIX: Núm. 112 (enero-abril, 1979), p. 129-142. Véase también Jorge A. Bustamante, "La interacción social en la frontera México-Estados Unidos; un marco conceptual para la investigación", en González Salazar, *op. cit.*, p. 26-45.

representará la primera minoría étnica de los Estados Unidos, concentrada especialmente en los estados más cercanos a la frontera. En los estados fronterizos del "otro lado", los angloamericanos suelen explicarse el por qué de su desvinculación económica y cultural del resto de los Estados Unidos, identificando a este último factor, o sea, a la población mexicana en los Estados Unidos, como causa de la primera, es decir, de su desvinculación económica y cultural. Desgraciadamente esta lógica de sentido común, en el mejor de los casos, y racista, en el peor, ha sido adoptada oficialmente por algunas autoridades norteamericanas. Al respecto, cabe recordar a William Colby, ex director de la CIA, quien no hace muchos años declarara que el enemigo número uno de los Estados Unidos era la creciente población mexicana en los Estados Unidos, peor amenaza para el sistema norteamericano que el comunismo.

Nosotros, por el contrario, pese a lo variado de las causas que explican la desvinculación económica y cultural por lo que se refiere al lado mexicano, sostenemos la hipótesis general de que ello se debe a factores de carácter interno, pero tampoco negamos que dicha configuración estructural se debe al papel que juega la economía mexicana con respecto a la economía norteamericana. Es, pues, la frontera mexicana la que recibe el mayor peso de dicha crisis estructural dependentista y en donde los problemas se agudizan más intensamente.<sup>3</sup>

El primer intento del gobierno mexicano para corregir dicha desvertebración se dio en la década de 1930 con la creación de perímetros libres en Baja California y, posteriormente, la zona libre en dicho estado y parte de Sonora. Después, en 1940 centró la atención en cuestiones de infraestructura urbana; para 1961, se inicia el Programa Nacional Fronterizo (ProNAF) con el fin de sustituir las importaciones de productos que se consumían en la zona, tratando de vincular así los intereses económicos de esa región con el interior del país. Cuando se agudizó el problema fronterizo por la terminación del Programa Bracero se creó, en 1965, el programa de las maquiladoras (Programa de aprovechamiento de la mano de obra sobrante a lo largo de la frontera norte con los Estados Unidos). Finalmente, se instituye el Programa de Desarrollo Fronterizo, puesto en marcha en mayo de 1971 y que tiene como propósito reafirmar nuestra soberanía económica y vincular el desarrollo de la frontera con el interior del país, sobre todo en cuanto al arraigo de los consumidores en el sistema comercial de la zona y la creación de medios de abastecimiento agropecuario e industrial locales.

Entre todas las soluciones que ha implantado el gobierno mexicano para resolver algunos de los problemas estructurales de la frontera, uno de los más controvertidos es la institucionalización del programa de maquiladoras, iniciado en 1965.

<sup>3</sup> Véase GARCÍA MORENO, "El impacto...", p. 130-131.

En relación a la maquila, hemos afirmado que ésta ha presentado ciertos rasgos negativos por las razones siguientes:

- a) En vez de vincular la frontera mexicana al resto de la economía del país, acentúa más la dependencia con respecto a la economía de los Estados Unidos;
- b) Si bien es cierto que crean empleos, ello es bastante relativo, ya que no todas las personas que migran hacia las fronteras atraídas por las maquilas encuentran empleo en las mismas y apenas si lo hace un porcentaje muy bajo del total de las personas movilizadas, creándose fuertes problemas en las ciudades donde se han asentado;
- c) Los llamados costos sociales exceden con creces a los supuestos beneficios de carácter económico;
- d) La capacitación de mano de obra dentro de la maquila es bastante mínima tanto desde el punto de vista del número de personas como por el tipo de entrenamiento recibido;
- e) La maquila es un elemento demasiado inestable por el carácter de la inversión realizada, por lo que en un proyecto nacional de desarrollo no puede ser tomada seriamente;
- f) Es un grave error que la legislación mexicana sobre inversiones extranjeras y propiedad industrial, *inter alia*, establezca un régimen completamente excepcional para las maquilas, ya que se debería prever su incorporación gradual con el resto de la economía del país.<sup>4</sup>

En suma, en términos de simple reactivación económica de la frontera mexicana puede decirse que las maquiladoras han tenido un cierto éxito, pero no en términos de una verdadera vinculación con la economía del país ni de un auténtico desarrollo.

II. En la primera parte de la ponencia, introducción, los autores ponen de manifiesto las enormes dificultades con que se encuentra un científico para medir los efectos socioeconómicos de la contaminación, planteamiento con el cual estamos de acuerdo.

Cuando los autores se refieren a que actualmente una sociedad, la contaminada, subsidia a la otra, la que contamina, vinculan el tema a la unilateralidad de la legislación, es decir, al carácter interno de la diversa legislación emitida en uno y otro país, México y los Estados Unidos, en el caso específico, pero que precisamente debido a la ausencia de acuerdos bilaterales, además de la insuficiencia de los esfuerzos legislativos para resolver el problema, resulta que dicha unilateralidad bene-

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<sup>4</sup> ANTONIO GONZÁLEZ DE LEÓN, "Factores de tensión en la frontera", en González Salazar, *op. cit.*, p. 18.

ficia a uno de los países en detrimento del otro, es decir, se tipifica el fenómeno del subsidio oculto o implícito de que hablan los autores de la ponencia. Pero lo más grave es que son sectores económicos o clases sociales los que subsidian a sectores económicos y clases sociales del otro país. Otro aspecto es que, los impactos económicos, léase costos del subsidio, tampoco se conocen; no se sabe de estudio alguno que contenga los costos directos o indirectos, los explícitos o los implícitos, los que implican flujo y aquellos que no representan flujo alguno.

Para exemplificar, los autores toman las conclusiones de otros estudios hechos sobre ciertas áreas fronterizas, y prueban los costos económicos, aunque sea parcialmente, pero lo más grave aún es el decremento en la calidad de la vida, especialmente de la población mexico-norteamericana, que en esa región resulta la más afectada, lo cual es extremadamente difícil de cuantificar económicamente hablando.

Cuando los autores se refieren a la selectividad demográfica demuestran que las fronteras, por ser de las áreas más probadas, son precisamente las que reciben un mayor impacto de la contaminación.

Al referirse los ponentes a los "factores políticos", asientan que el impacto político más obvio es la negociación de "varios acuerdos bilaterales" entre ambos países, especialmente en lo que concierne a problemas de recursos naturales fronterizos, sin realizar un análisis crítico sobre el contenido de dichos acuerdos, especialmente en lo que se refiere al Convenio para la equitativa distribución de las aguas del Río Bravo (Río Grande), del 21 de mayo de 1906, y el Tratado de Aguas, del 3 de febrero de 1944. Es probable que dichos análisis no se realice en la ponencia por estar fuera de los propósitos de la misma. Se examina el papel de la Comisión Internacional sobre Límites y Aguas (CILA) en el campo de la contaminación, especialmente de las aguas internacionales. Se menciona asimismo el Acta número 261 para resolver problemas de contaminación de aguas que afecten a poblaciones de ambos lados. Sin embargo, los autores observan que la CILA se ha limitado solamente a problemas relacionados con el agua, dejando de lado las otras fuentes contaminantes. La razón es muy simple: la competencia legal de la Comisión se concreta a límites y aguas, por lo que para que dicho organismo binacional amplie su esfera a la contaminación de otros espacios y fuentes deberá extenderse la competencia de la CILA. También se menciona, a un nivel menos formal, el memorándum de entendimiento, de 1978, y los mecanismos institucionales ahí establecidos, así como otros memoranda de entendimiento firmados posteriormente.

No obstante lo anterior, los autores resaltan que las actividades científicas binacionales sobre los efectos que se dan por la contaminación han sido mínimas.

A manera de conclusiones los autores de la ponencia afirman que:  
a) no hay un problema de contaminación, sino varios problemas; b) ni

los propios ciudadanos tienen conciencia de la contaminación sino hasta que son afectados por la misma; y, c) probablemente el escaso interés se deba a que muchos de los problemas no son aún urgentes, lo cual no indica que no lo lleguen a ser, eventualmente.

Para redondear lo afirmado por los dos ensayistas, formularemos las siguientes consideraciones:

Es abvio que dentro de las relaciones bilaterales México-Estados Unidos, algunos problemas se han liquidado, pero también es evidente que han surgido otros. Las razones son múltiples, afirma González de León:

... por una parte, nuestra vida de relación con el vecino del norte se ha intensificado y diversificado más y más. Por otra, la magnitud del crecimiento económico de los Estados Unidos y el carácter de superpotencia de ese país le plantean requerimientos nuevos y, en algunos aspectos, más amplios; requerimientos que tal vez, en ciertos momentos, pueden convertirse en exigencias frente a México, que nuestro país en base a sus propios intereses no pueda o no deba satisfacer; finalmente, los adelantos científicos y el desarrollo tecnológico de los últimos tiempos han hecho —en todo el mundo y, desde luego, en esta parte de él— que se planteen cuestiones que antes no se hubieran suscitado o se replanteen problemas que en algún tiempo parecían resueltos.

Precisamente dentro de los problemas nuevos que han surgido en las relaciones entre México y los Estados Unidos está lo relativo a la contaminación del medio ambiente, originado, entre otros, por la urbanización, la industrialización, el transporte, determinadas prácticas de riego y de cultivo, etc.

Es de suponer, por consiguiente, que mientras no se logre unificar la visión de los problemas, mientras no se uniformen razonablemente las legislaciones y las prácticas en ambos lados, la contaminación seguirá creando tensiones en la frontera a varios niveles: en cuanto al establecimiento de medidas preventivas y de reparación así como en lo que respecta al establecimiento de responsabilidades y solución de controversias. De cualquier manera es evidente que el problema ecológico es uno de los que encierran mayor diversidad de causas de tensiones, pero también es una materia en que, por el interés y la conveniencia de dos comunidades que comparten en gran medida el mismo habitat, puede esperarse una creciente colaboración y comprensión.<sup>5</sup>

<sup>5</sup> *Ibid.*, p. 23 y 24.

## COMMENTARY

THOMAS O. MCGARITY

Professor Weaver and Professors Downing and Restrepo have written two interesting and informative essays on the social effects that might result from efforts to protect the ecology and guide the development of the border area between the United States and Mexico. Since Professor Weaver's essay is far more theoretical than that of Professors Downing and Restrepo, it is difficult to compare the two essays to one another. I shall therefore discuss them separately and attempt to draw lessons from both into my discussion of each.

### I

The major thrust of Professor Weaver's interesting essay is to de-emphasize the importance of the *border* in describing the social effects of the ecology and development of the United States-Mexico border and stress the concept of *region*. While I agree with Professor Weaver that viewing the border area from this prospective can be very enlightening, I am also of the opinion that the fact of "border" is an important legal concept with its own social consequences that can be very important in defining the unique aspects of a border region.

#### *The Border Culture*

Professor Weaver does us a great service when he invites us to view the border as a "region", rather than as a dividing line between two separate cultures. I think that he has adequately supported his conclusion that the United States-Mexico border region "is a separate society, in a sense, with a unique culture of its own, made up of elements which overlap and come from the two mother cultures". I also agree with Professor Weaver that the concept of "frontier" has at best marginal relevance to the United States-Mexico border, because at best the border region is where two frontiers meet. Finally, I think that Professor Weaver is correct in suggesting that the "nodal region or central place"

better describes the United States-Mexico border than the homogeneous region concept.

Interestingly, however, Professor Weaver has not attempted to incorporate the ecologist's idea of region into his model. The concept of eco-system is central to the environmental manager's view of the world, and it has regional connotations. Like cultures and societies, eco-systems "are characterized not only by their parts but also by the interaction among these parts",<sup>1</sup> and "small changes in one part of an eco-system are likely to be felt and compensated for eventually throughout the system".<sup>2</sup> Although eco-systems or combinations of eco-systems, called biomes, rarely respect geographical boundaries, the various statutory efforts to control pollution in the United States have incorporated the concept of "region" to address the interconnected aspects of eco-systems. For example, Section 107 of the Clean Air Act establishes the "air quality control region" as the geo-political entity within which states must achieve the national ambient air quality standards which the federal Environmental Protection Agency sets pursuant to Section 108 of that Act.<sup>3</sup>

As is the case with socio-cultural regions, political boundaries often artificially bisect eco-systems. Yet while the division is artificial, it can have important consequences for the eco-system. The decline of the Great Lakes is probably a good example. It is of little consequence to the affected aquatic organisms in Lake Erie that pollutants are being discharged mostly from polluters on the United States side of the border between the United States and Canada. Yet that fact is of enormous importance to any effort to restore the lake and prevent future problems. Likewise, it may be that the cultural homogeneity of the United States-Mexico border region is of less relevance to solving existing social problems and anticipating future problems than the fact of the political border.

#### *The Legal Significance of the Border*

A political border has a wide variety of legal consequences for those living near it and those engaging in commerce across it, and some of these have social and ecological significance. Since the border separates two legal systems, different rules apply on different sides of the border. Professor Weaver has described some of the social consequences of this fact. Relaxed divorce rules in Mexico for a number of years attracted flocks of disgruntled spouses to the border for "quickie" divorces.

<sup>1</sup> HALLING and GOLDBERG, "The Nature and Behaviour of Ecological Systems", *Journal of the American Institute of Planners*, 37 (1971), p. 221.

<sup>2</sup> First Annual Report of the Council on Environmental Quality, 1970, p. 7.

<sup>3</sup> 42 U.S.C. 7407-08 (1980).

Changes in divorce laws in both countries virtually eliminated this phenomenon. As the laws became more similar the advantages of a trip to the border became less apparent. Currently relaxed prostitution laws (I presume) account for part of the nightly commerce across the border in the twin cities of Juárez-El Paso. I expect that if Mexico more stringently enforced its prostitution laws or the United States relaxed its laws, or both, the attractiveness of the border region for this purpose would also diminish. The point that I am making here is that it is not the border *per se* that accounts for these social phenomena; it is the fact that the laws are not uniform or are not uniformly enforced.

This point has broader social, economic ,and environmental significance. Let me give three examples that relate more closely to the general subject matter of this conference—*viz* ecology and development of the border region.

#### CROSS-NATIONAL EXTERNALITIES

Suppose a lead smelter is constructed along the border so that very few people living on one side of the border are exposed to lead emissions, but many people on the other side are threatened. The country in which the smelter is located has very little incentive to require the smelter to install stringent pollution control devices. This is a classic example of the economist's "externality". State A gets the benefits of the smelter—jobs, taxes, lead products—while State B suffers only costs—lead poisoning. As another example of this externality, I have been told that a large number of nuclear power plants in Europe are built along borders.

This externality problem can occur even if the region has a great deal of cultural and social homogeneity. The fact that my neighbor shares my race, culture and even politics will not stop me from shifting subtle costs to him if I can benefit thereby. The reason for the externality is the fact that affected persons in State B have no power to elect officials in State A to represent their point of view. The matter is left ultimately to diplomacy or to the international courts.

#### REGIONAL SOLUTIONS FOREGONE

Suppose that several companies in a nodal region produce toxic wastes which must be disposed of in an environmentally acceptable manner, and that most of those companies are located in State A. Suppose further that, according to the scientists and engineers, the ideal location (within a reasonable transportation distance) is ten miles from the border in State B. The companies in State A would like to dispose

of their wastes at that spot and the owner of the land would like to establish a hazardous waste disposal facility at that spot, but the citizens living nearby the facility do not want the facility to be located near to them. "Why", argue the citizens, "should we accept *any* risks to accommodate some other country's wastes?" Sufficient political controversy may be generated in State B to preclude the construction of the facility at the ideal site. This can happen irrespective of the cultural homogeneity of the region. It has happened in the United States in *Philadelphia v. New Jersey*, 437 United States 617 (1978). In that case the State of New Jersey banned the import of solid wastes from cities in states other than New Jersey. The City of Philadelphia, which heavily utilized New Jersey solid wastes disposal sites, and the companies that owned those sites argued that this violated the commerce clause of the United States Constitution. The federal Environmental Protection Agency (EPA) filed an amicus brief on behalf of the City of Philadelphia asserting that the waste should be disposed of in the most environmentally acceptable manner, even though the citizens of the State of New Jersey might prefer not to import wastes from another state. The problem, argued EPA, required a regional solution. The Supreme Court of the United States agreed with EPA and Philadelphia. No similar solution is possible, however, on the United States-Mexico border in the absence of a treaty or international agreement establishing the equivalent of a Commerce Clause.

#### EXPORT OF HAZARDOUS TECHNOLOGIES

When the United States Occupational Safety and Health Administration or the Environmental Protection Agency proposes to impose stringent health and safety standards upon employers or sources of pollution, the argument is invariably raised that companies will simply relocate hazardous facilities in other countries. Indeed, one of the primary rationales for the uniform technology and media-quality environmental standards in the Clean Air Act and Clean Water Act is the argument that in the absence of uniform standards, industries will shop around for the state or region that is willing to endure the worst pollution, rather than install pollution control devices in areas that are unwilling to suffer as much pollution.

Although I am not knowledgeable about the Border Industries Program described in Professor Weaver's paper, I would not be surprised if United States companies took advantage of this program to export some of the more hazardous aspects of their operations to Mexico.<sup>4</sup>

<sup>4</sup> I am aware of at least one instance in which United States drug companies, unwilling to comply with human experimentation regulations in the United States, contracted with a Mexican gynecological hospital to run drug tests on human

One can legitimately question whether the export of a hazardous technology from one country to another is in the best interests of either country. Sooner or later the hazards of the technology will be visited upon the receiving countries, with corresponding social problems. Once again, my point is that these transfers are likely to occur at border regions and bring their associated problems to those regions whether or not the population shares the same culture. It is the fact that the laws on either side of the border are different that causes the problems, not cultural differences at the border.

There are, of course, many regions throughout any country which exhibit a great deal of cultural and social homogeneity. It should not be especially surprising that over time a similar degree of homogeneity results from the interactions among different cultures. But this phenomenon is not necessarily limited to border regions. I am no expert on these matters, but I would expect that it is possible that some similar cultural assimilation occurs in large cities at the interfaces between ethnic neighborhoods. Once this interesting observation is made, however, it appears to me that what characterizes border regions most distinctively is the fact of differing rules of conduct on either side of the border. I have attempted to show how this fact can have considerable social and ecological consequences. In particular, I would urge that any effort to describe border regions begins with Professor Weaver's valuable starting point and proceeds to analyze the extent to which differing legal requirements generates social and environmental problems peculiar to border regions.

## II

Having concluded that legal rules do make a difference in border regions, it is a much more difficult question to determine what the content of those rules ought to be. Professors Downing and Restrepo offer some very insightful observations that can guide policy-makers on either side of the border toward a mutually agreeable solution or, in the absence of agreement, can at least provide students of the policy-making process with an explanation for why agreements may not be achievable.

### THE UNAVOIDABLE FACT OF SCIENTIFIC AND TECHNOLOGICAL UNCERTAINTY

Professors Downing and Restrepo are absolutely correct in stressing the importance of the uncertainties that arise in any attempt to assess

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beings under Mexico's less stringent laws. See, *Washington Post*, June 23, 1977, A. 1, col. 1; *Washington Post*, May 11, 1977, A. 1, col. 1.

the health and ecological effects of environmental contaminants. They are also correct to point out the difficulties that beset a policy-maker when he attempts to place dollar values on some of these effects. Scientific uncertainty and the inherent unquantifiability of many environmental effects combine to make environmental standard setting especially difficult. These problems continue to beset the Environmental Protection Agency in the United States more than a decade after it began attempting to set standards for pollutants in the environment. Acknowledging the difficulties in assessing the environmental and economic effects of pollution and pollution control strategies, it is probably even more difficult to assess the *social* effects of pollution or attempts to control pollution.

The uncertainties that becloud environmental standard-setting inevitably precipitate a wide divergence of opinion about the level at which standards should be set for particular pollutants in particular areas. Indeed, huge uncertainties about the "facts" and their implications necessarily convert otherwise "scientific" and "engineering" questions into *policy* questions. In the United States, the Environmental Protection Agency has struggled mightily to resolve the strong opposing political forces that have resulted. Yet even within the context of a single agency in a single government, this effort has proved only marginally successful. One would expect that attempts to resolve these questions within the context of a particular border region would be even less efficacious. In the absence of any Authority that can compel parties on both sides of the border to abide by its decisions, conflict is not likely to be resolved. There is simply no way to achieve concensus on these highly controversial questions.

#### REDISTRIBUTIVE EFFECTS OF POLLUTION AND POLLUTION CONTROL

I am intrigued by the authors' attempt to draw the concept of "selectivity" from ecological science and apply it to the social sciences. When studying the social aspects of ecological conditions in border areas, it is especially appropriate to begin with the observation that pollution and pollution control mechanisms can have important distributive effects. One of the most significant (though long ignored) aspects of pollution and pollution control is the fact that both can shift wealth.

Often this shift in wealth is invisible, just as pollutants themselves are often invisible. A person who contracts cancer 20 years after exposure to a carcinogenic environmental contaminant resulting from a production process may never know that the consumers of the product have benefited at his expense. This is attributable to the aforementioned

uncertainties that so often hamper attempts to establish cause-effect relationships between pollutants and health effects.

Occasionally, however, pollutants or pollutant controls quite visibly shift wealth from one definable class to another. For example, chemical oxidants are much more annoying to people suffering from asthma or bronchitis than to other people. Persons suffering from a hereditary immune deficiency called "serum alpha-antitrypsin deficiency" are likewise more susceptible to respiratory irritants.

The border likewise offers a unique opportunity to observe the shift of wealth due to pollution controls or the lack thereof. Forcing a smelter in El Paso to install a scrubbing system (to eliminate sulphur dioxide and particulates) quite obviously shifts wealth from United States shareholders and consumers to Mexican nationals who live in the border region. American consumers will pay more for batteries and other lead products. Mexican nationals will have fewer health problems and less material damage from the acid that sulphur dioxide forms in the atmosphere. I have already discussed how the fact of differing rules on different sides of the border makes this an especially difficult question to resolve.

The authors further make the incisive observation that the shift of wealth is not always from rich to poor. I found their example of materials effects due to sulphur dioxide emissions very informative. Indeed, one sometimes has to study the question very carefully to know whether pollution controls will shift wealth from poor to rich or from rich to poor. For example, it is conventional wisdom that requiring pollution controls in automobiles is akin to regressive tax on automobiles. The poor pay the same amount for the pollution control device as the wealthy, and this effect probably extends to the second-hand markets as well. Since the benefits of pollution control devices accrue to everyone more or less equally, it may be that a poor person pays disproportionately more for the benefit to himself. In the border areas that Downing and Restrepo discuss, however, it may be that automobile pollution control devices distribute wealth from the rich to the poor, because so few poor persons even own automobiles.

The important point to take away from this discussion is the fact that pollution and pollution controls can shift wealth, and occasionally the shift in wealth is patently obvious to those who would benefit from that shift and those who would suffer. This makes a political solution to the problem especially difficult, because concensus is virtually impossible. Thus it is not particularly surprising that Professors Downing and Restrepo conclude that not much has been done to solve the total problem of cross-border pollution.



## MODERATOR'S SYNTHESIS

ROLANDO HINOJOSA SMITH

The first essay on this topic by Professors Theodore E. Downing and Iván Restrepo dealt with the at once interesting as well as frightening forecast of the long term effects of pollution for future generations. The second essay is by Professor Thomas Weaver and presents a daring departure from Turner's theory of borders. His essay, however, was not focused directly on his theory vis-à-vis Turner's, but rather concerned itself with anecdotal references touching on a variety of subjects: labor, finance, juridical matters, and political considerations using primarily, the El Paso-Juárez twin cities as his base for discussion. The commentaries presented by Professors Thomas O. McGarity and Víctor Carlos García Moreno provided further information. When presented the papers and commentaries elicited a brief discussion from those present.

The Downing-Restrepo essay concentrated on its main topic: how present-day pollution bodes ill (communicable diseases, the debilitating of the balance of flora and fauna, principally) for citizens on both sides of the border. The stress upon the unknown consequences due to the resultant inconsistency and lack of interest by the offending industries upon the land, made it, then, easy for the offenders to continue their pollution, and difficult for those most directly affected: the population living near or about the polluted areas. The lack of a unified voice to publicize the present dangers is to be scored, of course, but the added difficulty in voicing—of proving, even—what future effects make a nettlesome and difficult presentation of these concerns even more onerous due to the lack of coordination and organization by those parties seeking redress; to add to this, both governments seem to favor the procedures of the polluters and not that of those who are most immediately affected by it now and for their families later on in time.

A further burden and certainly a point for added discussion was that scientists in their search for meaningful data were thwarted by the very nature of pollution, e. g., where one problem would be addressed, although not necessarily solved or eradicated, another would arise, and, if not in the very same locale, then further up or down the border. These very real frustrations when added to a dearth of hard and up-to-date data exacerbated the issues that needed addressing earlier, those pressing ones now, and, for our purposes, those to come.

In brief, strong lobbying, benign statutes, and organized public relations methods defeated the scientists' concerns for the welfare of the voiceless who, themselves, sensed the danger, but were (and are) not equipped for defending their own interests, interests which, of course, amount at times to nothing more than earning a livelihood in a clean, well-lighted place: their own homes, as it were.

Downing and Restrepo's presentation also focused on selectivity; a term which was defined, and which also pointed to additional social problems. For example, where an interest lay in exploring pollution's effects on water contaminants, others (scientists and interested parties) whose interest lay in atmospheric pollution or in that of fecal or solid contaminants, would be left out of this or that accord by the bureaucratic arm charged with implementation or with examination of existing laws or with programs which needed immediate attention. This is but one example, but it is familiar enough to those whose ambitions in solving human problems were dulled or dented by indifference, or worse, by methods of selectivity which prevent, by its very selectivity, a total, massive attack on the ever-widening breach between the affected population on the one hand, and on industry and the two governments on the other. A Scylla-Charibdis condition, therefore, where the first group's inability presents a danger to itself, and the second group's ability to render lip-service or much publicized self-service and thus lessen the appearance of danger; the scientists, between the two, are really between a rock and a hard place by subsisting, as they must usually, on financial consideration furnished by the producers and the two governments. When the scientists must select, and they usually must due to specializations often enough, and to time and to other considerations, the scientists, albeit loathing to select, must do so to stem at least part of the tide; mixing metaphors, then, it is a patch work kind of thing.

Professor Weaver's essay deserves further mention for its proposal which calls for a serious look at Turner's theories on the frontier. Weaver points out that there is no theoretical framework for analyzing borders or international boundaries; to form such a framework, he argues, one must do so through the process of commonality and not merely on political jurisdictions. The theory, then, must be based on border, frontier, section, region, and cultural considerations. The resulting principles and conceptualizations of the proceeding would constitute a theory on borders.

There was a description of Turner's theory as well as a description of the work done by those who have followed Turner's theory. The principal assertion in this regard was that those who followed Turner adopted explanations of multiple causation and thus saw and explained American culture as a product of many factors, such as European heritage, impact on world economy and history, the presence of ethnic groups, and other matters.

From this, the essayist presents the example of how Mexican population growth and the development of the northern Mexican states reveal how the presence of the border and its special characteristics influence Mexican institutions; he further adds that the concept of frontier does no deal with phenomena which merely overlap at the border. What happens, he goes on, is that the border area is the place where the frontiers of two nations come together thus intermingling aspects of two cultures and subsequent influences upon the institutions of both nations; briefly, Mexico's population growth and the development of the northern Mexican states are not isolated influences which affect Mexico alone; rather, they are closely tied to the northern neighbor's way of life as well.

An error in previous theories, he argues, came from viewing an international border as a boundary in a cultural, economic, and historic sense or as the end and beginning of two unrelated entities. Turner, then, saw it as one area of sectional interests and then modern economists related it as a region. Turner's motivation was due to his attempts to explain United States history. The concepts of section and region, however, do not adequately explain the nature of much overlapping activity.

Weaver also explained the nodal region and central place theories as regions which operate around cities, and because of this, economists use the central place theory in analyses of the city, and the surrounding community trading zone; as far as he knows, he says, the economists did not apply the theories on analyses of towns along a political border.

In the nodal region and central place theories (in the case of Juárez and El Paso) a complete analysis would be available only by knowing how twin cities provide goods and services to the small places in the region; of interest, of course, is that Juárez also serves other American cities (Las Cruces, Albuquerque) and El Paso, in turn, services other Mexican cities (Ciudad Chihuahua, Parral).

Professor Weaver's theory leans heavily on notions of subculture as a variant or as a portion of a culture shared by a subsequent one of a larger society such as an occupational or ethnic group. The use of culture, however, is not made at the expense of everything else; it, too, is one further tool in his theoretical framework.

In brief, then, a premise to remember when working with border areas is that the notion of border as a boundary which separates two sets of social and cultural phenomena is grossly inadequate. And, this comes from placing too much focus on "border" as a dividing line, and this then obfuscates the overlapping activities on both sides of the border. The term "frontier" as used by Turner and others does not account for how happenings in one country affect laws and institutions in the society of another. A further suggestion by Professor Weaver is that the concep-

tualization framework of a region lends itself to a border area which encompasses territory on both sides of a political boundary.

On economic features, it is then suggested that trade and service of the hinterlands of border towns and cities include (again) the area on both sides of the border; finally, twin cities have a symbiotic relationship in furnishing mutual services.

In closing this part of this synthesis, it is fitting to use Weaver's precise words in the summary: "In sum, we are suggesting a cultural view of the United States-Mexico border region which takes the border as the center of an area which encompasses a portion of the political domains of the two bounded societies; it is a separate society, in a sense, with a unique culture of its own, made up of elements which overlap and come from two mother cultures. The culture of this subsociety would include those characteristics listed above as elements of a border cultural region."

Professor McGarity's commentary consisted of a series of cogent reminders that the legal systems of both countries must always be uppermost in ecological concerns with particular reference to border regions. It is not that one country has more or less stringent laws (civil, criminal, etc.) or that adherence to them is not uniform, but rather that the laws themselves are not uniform. There needs to be, then, not only equal application of the law on either side of the border, but also pacts, treaties, or international agreements between the two governments. Touching on both the Downing-Restrepo and Weaver essays, Professor McGarity demonstrated how mobility by the offending industries or even the threat of moving elsewhere serves as a further hindrance to the alleviation of pollution along a border eco-system. As things now stand, some businesses would merely relocate to friendlier or to less stringent regions rather than to spend resources on filters or whatever is needed to clean the air of contaminants. The threat of deprivation of business and the lack of uniform standards more than likely sway the argument in favor of the polluters.

At bottom, however, are the legal aspects, and one must look to the existing laws of both countries which can lead to alleviation, possibly eradication, of the social problems created by pollution. To sum up, without a legal basis and without agreed-to uniform legal standards, the social problems will continue. Enforcement, of course, would be facilitated by the laws' uniformity.

Professor García Moreno's commentary on Professor Weaver's presentation focused on the premise that the border region, as important as it is, has not received enough attention from the Mexican government; by contrast, the border region has been widely explored in the United States and particularly by American academics. His first point was that Mexico's dependency on the American economy is salient for the understanding

of border problems. Moreover, despite the dependence of United States border cities on Mexican trade across their common border, Professor García Moreno stated that the United States border cities consider themselves isolated from the rest of the United States economy (due to a lack of technological development and other factors). To this isolation, however, one must also consider the vast first generation Mexican population now residing, on both sides, along the 3,600 km. border. He went on to comment that the United States position in re the economy and cultural isolation of the United States border cities, from the rest of the country, was due to the presence of a large Mexican population on the United States side; Professor García Moreno also stated that this attitude had been adopted, officially, by some United States authorities.

On the Mexican side of things, he said that Mexico's reasons for economic dependence reside in Mexico's own internal problems as well, but that these were exacerbated by the continuing Mexican dependency on United States economy. The border, then, being a further example of this dependency.

Professor García Moreno also traces the attempts by Mexico of solving these dependency problems beginning in 1930 and into the '70s with the formation of various Mexican Federal programs to build up its own border economy. (The 1965 *maquiladoras* program, as an example, sought as an alleviation of the Mexican border economy served to further dependence: the problems created were more than the benefits derived, and this was but one example).

He also commented on the Downing-Restrepo presentation. Professor Garcia's contention is that the ongoing spirit of United States unilateral actions work against its neighbor. More importantly, though, is that there is no study that addresses a far reaching issue: the cost to both economies and its population by certain economic factors and certain social classes in each country which subsidize each other with no regard for the border ecology and economy.

Professor García Moreno then recognized that certain bilateral agreements have proved beneficial, but this notwithstanding, other problems have arisen and they, in part, are due to an intensity as well as a diversification of the economic relations, and, in a greater part, due to the United States' obvious superiority in economic power.

These new problems, he summed up, point for an increase in pollution due to many factors of which the following are but a few: increased urbanization and industrialization, water and land use and misuse.

In response to a question, Professor García Moreno laid part of the problem on the United States and what he termed its recalcitrance in dealing with Mexico in solving these problems directly.

## RESUMEN EN ESPAÑOL

La ponencia de los profesores Theodore E. Downing e Iván Restrepo, que constituyó la primera de la sesión sobre este tema, trata de los efectos a largo plazo que causará la contaminación a las generaciones futuras. Por su parte, la ponencia del profesor Thomas Weaver, segunda en el orden en que fueron presentadas, aborda un enfoque valiente a partir de la teoría de las fronteras de Turner.

El trabajo de Downing y Restrepo se enfoca hacia los problemas actuales de la contaminación y destaca la falta de interés de las industrias de la zona fronteriza en los mismos. También, en ausencia de una defensa adecuada de la ciudadanía, se propicia una política aparentemente favorable por parte de los dos gobiernos hacia las industrias contaminantes. Así, los científicos tienen que tomar partido entre los grupos que se forman implícitamente y, por razones de trabajo, se deciden frecuentemente por el último grupo.

El profesor Weaver establece en su ponencia que al no haber una estructura teórica para el análisis de problemas en líneas divisorias o en fronteras internacionales, es necesario crearla con base en la comunidad y no solamente sobre aspectos jurídicos; la teoría habría de fundamentarse en los conceptos de línea divisoria, frontera, sección, región, así como en aspectos culturales.

El profesor Thomas O. McGarity, comentarista de la sesión, observa que las leyes no son uniformes en cada país (por lo que se refiere a los asuntos fronterizos) y que debiesen aplicarse igualmente en cada lado de la frontera. Además, es necesario instrumentar pactos, tratados o acuerdos internacionales. Agrega, en otro aspecto, que al establecer normas rigurosas para regular la contaminación, las industrias podrían trasladarse a otros sitios y que esta sola amenaza obstaculiza o retarda una legislación más adecuada.

Finalmente, el profesor Víctor Carlos García Moreno, también comentarista de la sesión, centra su punto de vista en que el gobierno mexicano no le ha prestado suficiente atención a la frontera. En cuanto a los Estados Unidos, sus ciudades fronterizas se consideran aisladas de la economía nacional. Al afirmar la dependencia de México de la economía de los Estados Unidos, apunta hacia un problema que no se ha estudiado: el costo de las formas en que se subsidian las comunidades de uno y otro país.

*A CULTURAL INTERLUDE:  
HONOR ESSAY*

VI

ENSAYO DE HONOR:  
UN INTERVALO CULTURAL



## THE CORRIDO: YESTERDAY AND TODAY

AMÉRICO PAREDES

It is a great and unmerited honor that you do me in having me as your essayist of honor. I feel singularly unqualified, however, to be part of a symposium of this kind, dealing with the hard data about the United States-Mexican border. On top of that, I am dealing with a topic that to most Mexicans is not only well known but well worn: "The *corrido*".

How to relate an essay on the *corrido* to subjects such as natural resources and the social effects thereof? Perhaps I should argue that the *corrido* is one of Mexico's natural resources. At the very least, we can agree in recognizing the *corrido's* relationship to social conditions, not only as effect but as contributing cause to such conditions.

The *corrido* belongs to the category of popular music known during the *porfiriista* period as *canciones de petate y pulquería*. During the Revolution such songs were raised from their lowly status to a pinnacle of national esteem. The *corrido* merited the attention of scholars and poets, novelists, musicians, and artists. But that is history. If contemporary Mexicans do not refer to such music as *canciones de petate y pulquería*, it may be because *petates* and *pulquerías* no longer figure as parts of Mexican culture. Folksongs—and folklore in general—are not held in high regard. In the press, *es puro folklore* is equivalent to *es mentira*. *Un folklorista*, at best, is a scruffy young man with a guitar; at worst, a charlatan... or perhaps a tourist guide. Now, I do not wish to belittle the economic importance of the tourist industry. But it is regrettable that, in the view of so many, the social values of folklore are confused with the monetary value of tourism.

The initiator of scholarly interest in folksong was the Englishman Thomas Percy, a highly respected Sanskrit scholar of the 18th century. Modern study of folklore, however, begins with Johann von Herder, 18th century literary critic and philosopher, who found in folksongs the ethnic "soul" or character of the people who sang them. Herder was an important influence in the German drive toward a national literature and a feeling of identity and self-respect. Other countries in northern

Europe, notably Finland and Ireland, also turned to folklore as one means of achieving a sense of unity and ethnic pride.

Early in the 20th century—as we well know—Mexico would repeat the German experience. There were some important differences, though. German folklore scholarship focused not only on the folksong but on other genres as well—notably myth and folktale—and it was informed not only by romantic nationalism but by some of the best of 18th century scholarship. Intellectuals of the Mexican Revolution, on the other hand, were interested mainly in folksong, especially the *corrido*, which they valued not only for its social implications but for its historical connection with the Spanish *romance* of the wars against the Moslems. And Mexico produced no Herder, though it had a Thomas Percy in Vicente Mendoza, the great collector and compiler of folklore. Though respected scholars did incidental work in folklore, the major Mexican folklorists kept their distance from scholarly disciplines such as anthropology, history, linguistics, and sociology. They were enthusiastic amateurs, inspired by the romantic nationalism of the era. Characteristically, they fluctuated from a *superindigenista* stance, according to which only Indians had real folklore, to an equally extreme *hispanista* position, which claimed a direct link between the *romance* and the *corrido* and maintained that genres like the riddle and the folktale did not exist among indigenous groups. Meanwhile, the *corrido* was pre-empted by middle-class machismo and the movie charro. Vicente Mendoza, with some justice, declared that the “true” *corrido* was dead by the 1930s.

Mendoza identified three main stages in the life of the *corrido*, corresponding to three important periods in recent Mexican history. The first is the *porfiriista* period, from the late 1870s to 1910. The *corrido* develops during this time; its heroes are the insurrectionists and outlaws who challenged the authority of the government. The second stage, the time of the *corrido*'s highest development, coincides with the Revolutionary period, 1910 to 1929. Its heroes are of course, the men of the Revolution, its main themes are battles and the execution of famous generals. The third stage, after 1930, is a period of decline and degeneration that leads toward complete vulgarization of the *corrido* and perhaps to its total disappearance. And, by the 1950s, it was difficult to disagree with Mendoza's gloomy view of the *corrido*'s future. All one had to do was turn on the radio to a Mexico City station and listen to a movie charro groan out a *corrido* in imitation of Frank Sinatra or Elvis Presley, while an audience of teen-age girls squealed in the background.

Mendoza's portrait of the *corrido*'s rise and fall is vivid and precise. But he neglected an area important in the history of Mexican popular culture, where the *corrido* is far from dead. I refer to the geographic

area of northern Mexico and southwestern United States—the border area, that Mexican intellectuals persisted in ignoring for so long.

We can follow Mendoza's example and divide the life span of the border *corrido* into three stages. (Three is such a convenient number.) The first stage covers the period from the 1850s to the 1930s, antedating Mendoza's *porfirista* stage by a couple of decades and continuing through his Revolutionary stage. We may note of Mendoza's first two *corrido* stages that they were periods of social struggle. The first one was characterized by class conflicts, symbolized by the semilegendary deeds of outlaws of the Robin Hood type, who robbed the rich to give to the poor—*corrido* heroes such as Heraclio Bernal. The Revolutionary stage, of course, was a period of political conflicts and civil war, with *corrido* heroes who represented the different Revolutionary factions. The eighty-year-long first stage of the border *corrido* was also a period of conflict. Class differences played a part in this conflict, since after 1848 Mexicans in southwestern United States were economically exploited. But the main emphasis is on culture differences, on ethnicity, with politics playing a secondary role. The so-called bandits who became border *corrido* heroes during this period were men like Juan Nepomuceno Cortina, Catarino Garza, and the leaders of the *sedicioso* movement of 1915. They were not highwaymen like Heraclio Bernal but thought of themselves as *mexicanos* and as revolutionaries, who made public a stated list of grievances they hoped to redress by taking up arms against constituted authority. Or they were men like Gregorio Cortez and Jacinto Treviño, who got into trouble with the law while defending their individual rights against a repressive social system. During this period, even tequila smugglers—and occasionally a train robber such as José Mosqueda—might be enveloped in the aura of ethnicity by the *corrido* singers. Only in the *corridos* about migrant workers is class equal in importance to ethnicity.

The second stage of the border *corrido* covers the period from 1940 to 1965, and like Mendoza's post-1930 stage it is a period of decline. It is not the end of the Revolution in Mexico, however, as much as the advent of World War II and the war's aftermath that signal the change. *Corridos* are still composed (in Austin, Texas, as well as on the border), but they are about local events.

Then—on the 16th of September of 1965, César Chávez's National Farm Workers initiate the Movimiento Chicano with their "Plan de Delano". It is typical of what was to follow that the farm workers justified their demands for social justice by appealing to a phrase long in Mexican oral (as well as written) tradition and attributed to Benito Juárez: *El respeto al derecho ajeno es la paz*. The Movimiento spread to the *barrios* and the universities, and it found expression in Mexican folklore, particularly in the *corrido*, which experienced a rebirth as it

again became relevant to aspirations of social change and to ethnic conflict.

This period, not quite ended at the present time, reveals some interesting parallels with Mexico's Revolutionary period. First of all, the symbols and dominant figures of the Revolution are adopted as symbols of the Movimiento. Some of the excesses of the Revolutionary times have also been adopted by the Chicano intelligentsia, for example *superindigenismo* (or perhaps one should call it *superaztequismo*, since only the Aztecs are most commonly romanticized). This is at the expense (paradoxically) of Hispanic culture. "Paradoxically" because many of those whom I have heard extol Cuauhtémoc and damn Spain for the supposedly noxious effects of its presence in Mexico, were at the same time fighting for bilingual education and the right to speak Spanish at school. Following a pattern that goes back to Herder's Germany, the Movimiento Chicano has striven to create a distinctive Chicano literature and art based on pre-Columbian symbols and contemporary Mexican folklore. All forms of folklore have been used to express the ideals of the Movimiento and to foster ethnic identity and pride, but again—as with the Revolution—the *corrido* has a special place in their view of folklore.

They very label "corrido" has a certain magic. In reading the folksong collections of Vicente Mendoza, Rubén Campos, and other Mexican romantic nationalists, one is struck by the extreme elasticity of their standards in identifying certain folksongs as *corridos*. *Habaneras*, *décimas*, *mazurkas*—almost anything—was a corrido if it expressed the right sentiments. Chicano composers and performers are following the same tradition. There are some *corridos* in *cumbia* rhythm, for instance, and others with a strong infusion of United States Anglo musical styles. But objecting to such a process would be scholarly carping. Social cause and effect transcend the formal aspects of folksong. Folklore genres come and go, while sociocultural expressions continue in more current forms. They will continue as long as there are unresolved problems, economic inequalities, and ethnic conflicts.

Even since scholars began to study folklore, they have been aware that its strengths and its weaknesses are inseparably intertwined. Herder's enlightened interest in folksong is followed a century later by Hitler's racism. Mexican intellectuals long ago saw the need to move from the xenophobic, self-centered nationalism fostered by some of the uses made of the folklore of the Revolution, to get out from behind the Cactus Curtain, as Carlos Fuentes said somewhere. To them, *corridos*, *mariachis*, *canciones rancheras*, and even the works of such popular composers as Palmerín, Tata Nacho, Guty Cárdenas, and Agustín Lara are uncomfortable reminders of the past. But one must understand that to Chicanos, these things belong to the present because for them they have immediate

social and political significance. We must not, in sum, lose sight of the social significance of song.

And thus we see the Chicano reliving Mexican history of half a century ago. But the old-style *corridos* are still being composed and sung along the border. Few of them, however, sing of heroism, independence, adventure, or hard work, as they once did. Their themes for the most part are of the "vulgarized" type that Mendoza deplored as the last stage of the Mexican *corrido*—the *tragedias* of blood and bluster. However, if today's *tragedias* treat mostly of the squalid themes of life, it may be that too many Mexicans do live lives of poverty and squalor. This is especially true of the border. We all recognize that as problem—a border problem, we might say.

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#### NOTES

*Among German Scholars:*

- JAKOB AND WILHELM GRIMM  
MAX MÜLLER  
FRANZ BOPP  
THEODOR BENFEY  
AUGUST SCHLEICHER  
FRIEDRICH SCHLEGEL



*THE SYMPOSIUM IN RETROSPECT*

VII

EL SIMPOSIO EN RETROSPECTIVA



## PROBLEMS AND PROCESSES OF DEVELOPING RESEARCH ON A "NEW" AREA

### THE UNITED STATES-MEXICO BORDER

JAMES W. WILKIE

It is perhaps symbolic that at the midpoint of this symposium on Mexican-United States Border Studies, the Mexican government devalued the peso. Is it only coincidence that this occurred while the leading Mexicanists were not in Mexico?

This conference and my summation of it, then, are set against the overnight float of the peso in which the dollar will now buy 38 instead of 27 units of Mexican currency, according to the Bank of America representative with whom I spoke in Los Angeles at 6:00 PM Austin time. The speculation is that the peso will float to at least 42; and my own prediction before the event was that it should be at 45. At any rate we know that the peso has been devalued by a percentage change of at least 40%. I told one Mexican colleague at lunch, "don't worry, the peso hasn't been devalued—its only 'floating', as the government likes to say". The response was, "If a 40% loss means a floating peso, then what will happen when the peso 'sinks'?" Another colleague said that he hopes that my summation tonight will be worth more than the peso. My rejoinder was that I hope that it is worth more than the dollar is worth in Japan. In these times Mexico and the United States are in much the same boat in terms of currency and that boat may be indeed "sinking"!

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With regard to the substance of these meetings, one observer asked me yesterday, "If the United States can send men to the moon, why can't it resolve the problem of the United States-Mexico border?" One answer is that until now it has been more difficult to study the border than the moon because it has been a "backwater" of scholarship. A prominent scholar has previously put the matter in the following terms:

"It has not been professionally rewarding for most of us on either side of the border (and especially economists) to be identified with what too often has been considered to be a 'narrow, regional topic of investigation'."

An alternative answer to the question about "men and the moon" is to say that there is not any one problem of the border but a series of complex and interlocking issues that we have only just begun to inventory (never mind resolve), as this symposium has shown us implicitly.

Another observer at the symposium asked me, "Is it enough to mainly undertake here a general inventory of ecological problems and to attempt to define the range of issues?" I responded affirmatively and explained the matter as follows: It is through these conferences that we are developing a tradition that has only recently begun to give scholarly importance to the border, importance needed so that researchers can approach the topic and expect to be rewarded academically for undertaking "mainstream" research.

By bringing together this august group to undertake a more delimited analysis than was developed at the First Binational Symposium in La Paz in 1980, we not only bring together yet another set of scholars who have been conducting important research on the border and yet another set of observers whose interest we hope to whet, but also we gain the following:

First, each of us has had time to focus on issues here and to pull together some thoughts previously not related in our thinking.

Second, we now are aware that no matter that the topic here was delimited from the general themes at La Paz to the particular theme of this meeting, this delimited topic has proven much more complex than was thought at the outset. The same is probably true of any topic we could devise.

Third, we have seen that when a *ponente* goes deeply into one subtopic, the commentator reminds us of areas not covered, even though they are not within the expertise of the investigator. Clearly this problem could have been precluded had the sessions been titled differently; for example, "Case Analyses of Natural Resources" instead of "Natural Resources". An alternative would have been to extend the symposium to meet for ten days instead of two, if even that extension would give enough time. Or the symposium could have provided a forum for a superficial briefing on dozens of subtopics not covered here. In my view the symposium has struck a balance in the coverage of possible material:

- A wide variety of issues has been raised to suggest directions of future research.
- Some topics have been treated with the depth necessary for publication of these proceedings.

Fourth, we realize that the complexity of subtopics is such that off-shore oil resources was not taken up in the category of "Natural Resources" but in the category "Water". And during the session on "Social Aspects of Ecology and Development", it was remarked that the entire symposium could have been developed on that theme alone. In reality, the social panel might have functioned in a more focused way for this symposium if it had been divided so that as part of each ecological session ("Water", "Air", "Natural Resources") an essay on social impacts had been presented.

Fifth, it has become clear that the "Humanistic Aspects of Ecology and Development" have only been discussed here tangentially. One humanist observer told me, tongue-in-cheek, that attending this conference marks the first time he ever had to consider, implicitly, the relationship of air particles to culture.

In surveying the papers presented at this symposium, I conclude that we are long on problems and short on solutions. Even the solutions seem to be problematic, as in the case of developing energy from plants (too expensive as yet) or developing salt resistant agriculture (which in the long run will not succeed if soil becomes completely saturated with salt).

Some problems that have emerged in discussions at this symposium include, for example:

- defining the population of the Mexico-United States border (I heard figures ranging from 6 to 7.5 million for the same year in different presentations);
- comparing cross-border maps based upon differing conceptions, methodologies, and scales;
- matching long-term climatological data on one side of the border with short-term data on the other side;
- understanding very different legal systems, units of government, and ideas about gathering of basic data from one side of the border to the other;
- developing a United States "national agenda" for research on the border—even if that were possible, it would be presumptuous to develop a United States agenda without taking into account debates over priorities in the Mexican scholarly world;
- placing the United States-Mexico border into a comparative perspective of borders throughout the world;
- studying the different roles of public and private policy in Mexico, in the United States, and across the border.

Such problems cannot be "resolved" or even studied until they are identified and enough scholars on both sides of the Mexico-United States

frontier realize that the idea of the border is important. It is through these Binational Symposia focused on the border that we are forging interest in and new ways of looking at United States-Mexico relations. Although the Mexican and United States governments may now hardly believe that border issues are pressing in light of many crises facing each country, let us remember that governments are often five to seven years behind scholarly identification of issues. The basis laid here in stating issues will have a long-range impact through publication; as ideas presented here are taken up in further research, there will be a widening and deepening amount of information made available on both sides of the border. Too, border scholarship may change over the next years as it offers a case-study approach to broader United States-Mexico relations.

These Binational Symposia illustrate the fact that although Mexico-United States border scholarship can no longer be considered far from the mainstream of academia, we can only be humbled by how little is our state of knowledge. We are only beginning to organize and re-organize knowledge about the border as we find new dimensions of it, many of which have yet to be conceived.

Let me close by saying that the directors of PROFMEX and ANUIES have unanimously agreed that this Austin Symposium has, strengthened the tradition of developing important new scholarship on the Mexico-United States border. Therefore, we agreed in principle to hold a Third Binational Symposium in 1983. The theme and place of meeting remain to be determined, but the challenge of defining and the process of studying our common border has become clear here in Austin. We have agreed that PROFMEX and ANUIES ought to continue to meet that challenge. We ask you to join us in this endeavor.

# PROBLEMAS Y PROCESOS PARA EL DESARROLLO DE INVESTIGACIÓN EN UNA "NUEVA" ÁREA

## LA FRONTERA MEXICO-ESTADOS UNIDOS

JAMES W. WILKIE

Es quizá simbólico que a la mitad de este simposio sobre Estudios Fronterizos Mexico-Estadounidenses, el gobierno mexicano devaluó el peso. ¿Es sólo coincidencia que esto ocurriese mientras los más connotados mexicanistas no estaban en México?

Esta reunión y mi relatoría sobre ella contrastan con la flotación del peso anunciada ayer por la noche y por la cual el dólar comprará 38 unidades de moneda mexicana, en lugar de 27; todo esto según me lo comentó el representante del Bank of America, con quien hablé a Los Angeles ayer a las 6:00 p. m., tiempo de Austin. Se especula que el peso flotará a 42, por lo menos, y mi propia predicción, antes de que aconteciera la devaluación, lo situaba en 45.

A cualquier cotización, sabemos que el peso se ha devaluado en un mínimo de 40%. Le decía a un colega mexicano durante el almuerzo "no te preocupes, el peso no ha sido devaluado, solamente está flotando" tal y como acostumbra decirlo el gobierno. Su respuesta fue "¿si una pérdida del 40% significa que el peso flota, qué sucederá cuando el peso se hunda?" Otro colega me dijo que esperaba que mi relatoría de esta noche fuese más valiosa que el peso. Agregué que esperaba que fuese más valiosa que el dólar en Japón. En estos tiempos y por lo que se refiere a su moneda, podría decirse que México y los Estados Unidos de América están en el mismo barco y que el barco puede estarse... "hundiendo".

En lo que concierne a la esencia de estas reuniones, un observador me preguntó ayer "¿si los Estados Unidos pueden enviar hombres a la luna, por qué no pueden resolver el problema de la frontera entre México y los Estados Unidos?" Una respuesta posible es que hasta ahora ha sido más difícil estudiar la frontera que la luna porque en la primera hay un "estancamiento" del conocimiento. Anteriormente, un prominente académico describió la situación en la forma siguiente: "Para la mayoría

de nosotros (y particularmente para los economistas) en cualquier lado de la frontera, identificarse con un campo que frecuentemente se ha considerado como 'un tema de investigación regional y estrecho', profesionalmente, no ha sido reconocido en forma adecuada."

Una respuesta opcional a la pregunta sobre los "hombres y la luna" sería que no hay ningún problema aislado en la frontera, sino una serie complicada y entrelazada de situaciones que justamente principiamos a inventariar (no a resolver), como lo muestra implícitamente este simposio.

Otro observador del simposio me preguntó "¿es suficiente levantar aquí un inventario general de problemas ecológicos e intentar definir el alcance de las situaciones?" Le respondí afirmativamente y le expliqué el asunto como sigue: es verdad que en estas reuniones estamos desarrollando una tradición que recientemente empezó a darle importancia académica a la frontera, importancia necesaria para que los investigadores se interesen en el tema y puedan ser reconocidos académicamente por realizar investigación en una dirección relevante.

Al integrar este grupo serio para que efectuara un análisis más delimitado que el que se desarrolló en el Primer Simposio Binacional en la Paz, en 1980, no se formó únicamente otro grupo de académicos que han dirigido una importante labor de investigación en la frontera y uno más de observadores cuyo interés esperamos estimular, sino que también ganamos lo siguiente:

*Primero.* Cada uno de nosotros ha tenido tiempo para enfocar los aspectos tratados en esta reunión y relacionarlos con reflexiones propias que previamente no habíamos vinculado a los mismos.

*Segundo.* Ahora hemos advertido, que si bien el objetivo de este simposio fue delimitado de los temas generales de la Paz con la finalidad de ahondar en la temática que nos ocupa, aquél resultó mucho más complejo que lo que se pensó en un principio. Y quizá lo mismo habría ocurrido si se hubiese propuesto cualquier otro objetivo.

*Tercero.* Hemos observado que cuando un *ponente* profundiza en un subtema, el comentarista nos recuerda áreas que no fueron cubiertas, aun cuando no están dentro de la especialidad de este último. Seguramente, el problema se habría evitado si las sesiones se hubiesen titulado en forma diferente; por ejemplo, "Análisis de Casos en Recursos Naturales" en lugar de "Recursos Naturales". Otra opción habría sido la de prolongar el simposio y reunirnos por 10 días en lugar de dos, en el supuesto de que tal periodo hubiese sido suficiente. O, por otra parte, el simposio se podría haber convertido en un foro para tratar superficialmente docenas de subtemas no cubiertos en esta reunión. Desde mi punto de vista, el simposio ha logrado un balance en la cobertura de diversos aspectos:

- Una amplia variedad de temas ha sugerido directrices de investigación para el futuro.
- Algunos puntos fueron tratados con la profundidad adecuada para publicarse en las memorias del simposio.

*Cuarto.* Comprendemos que la complejidad de algunos subtemas fue tal que nos hizo tratar los recursos petrolíferos en el mar dentro del tema del "Agua" en lugar de tratarlo en "Recursos Naturales". También, durante la sesión sobre "Aspectos Sociales de la Ecología y el Desarrollo", se dijo que el simposio pudo haberse dedicado solamente a este tema. En realidad, la sesión panel sobre aspectos sociales pudo enfocarse mejor si se hubiese subdividido de manera que en cada sesión de ecología ("Agua", "Aire", "Recursos Naturales") se hubiese presentado un trabajo sobre las repercusiones sociales.

*Quinto.* Por otra parte, resultó que los "Aspectos Humanísticos de la Ecología y el Desarrollo" se trataron en la reunión sólo en forma tangencial. Un observador del área humanística me dijo al oído que como consecuencia de su asistencia a la reunión, por primera vez tenía que considerar, implícitamente, la relación que existe entre las partículas del aire y la cultura.

Al repasar los trabajos presentados en el simposio, concluyo que tenemos muchos problemas y pocas soluciones. Aún las soluciones son problemáticas, como en el caso de la producción de energía a partir de plantas ((todavía demasiado costosa) o el desarrollo de una agricultura resistente a la sal (la cual no tendrá éxito a largo plazo si el suelo se satura completamente con la sal).

En las discusiones del simposio han surgido algunos problemas que incluyen, por ejemplo:

- el cálculo de la población en la frontera México-Estados Unidos (escuché cifras entre 6 y 7.5 millones para el mismo año en diferentes trabajos);
- la comparación de mapas transfronterizos basada en distintas concepciones, metodologías y escalas;
- la relación de datos climatológicos a largo plazo en un lado de la frontera con datos a corto plazo en el otro lado de la misma;
- el conocimiento de sistemas legales muy diferentes, de dependencias gubernamentales y de ideas acerca de la recopilación de información de datos básicos de uno y otro lados de la frontera;
- el desarrollo de una "lista nacional" estadounidense para investigación en la frontera. Aun si ello fuese posible, sería presuntuoso elaborar la lista sin tomar en cuenta debates sobre prioridades en el mundo académico mexicano;

- la consideración de la frontera entre los Estados Unidos y México en una perspectiva de comparación con las fronteras en todo el mundo;
- el estudio de los diferentes papeles que juegan la política pública y la privada en México, así como en los Estados Unidos y a través de la frontera.

Estos problemas no pueden resolverse, o ni siquiera estudiarse, hasta que se les identifique plenamente y hasta que un número suficiente de académicos, en ambos lados de la frontera México-Estados Unidos, comprenda que la idea de frontera es importante. Es a través de estos Simposios Binacionales enfocados al estudio de la frontera, como se forja el interés en el tema y en las nuevas formas de concebir las relaciones entre los Estados Unidos y México. Aunque los gobiernos mexicanos y estadounidense difícilmente creerían que los asuntos fronterizos lleguen a presionar a la luz de muchas otras crisis que enfrenta cada país, recordemos que los gobiernos se encuentran frecuentemente de cinco a siete años atrás de la identificación académica de dichos asuntos. La base establecida en la reunión para formular los problemas tendrá una repercusión de gran alcance a través de la publicación de las memorias; como las ideas que se han presentado en el simposio serán objeto de investigación ulterior, se dispondrá de una información cada vez más amplia y especializada en ambos lados de la frontera. Además, el interés académico puede cambiar en los próximos años conforme se ofrezca un enfoque definido de problemas de investigación que permita ampliar las relaciones entre los Estados Unidos y México.

Estos Simposios Binacionales ilustran el hecho de que aunque el interés académico por la frontera entre México y los Estados Unidos no puede considerarse por más tiempo muy lejano de la corriente principal de los investigadores, somos conscientes de las limitaciones del conocimiento actual en la materia. Estamos comenzando a organizar y reorganizar el conocimiento sobre la frontera conforme le encontramos nuevas dimensiones, habiendo aún muchas que están por descubrirse.

Permítaseme concluir participándoles que los directores de PROFMEX y ANUIES coinciden al afirmar que este simposio de Austin ha fortalecido la tradición de desarrollar un importante y nuevo interés académico y por la frontera entre México y los Estados Unidos. Todo esto nos ha permitido acordar, en principio, realizar un Tercer Simposio Binacional en 1983. El tema y el lugar de la reunión se determinará posteriormente, pero el desafío para definir y el proceso para estudiar nuestra frontera común ha sido claro aquí, en Austin. Estamos de acuerdo en que PROFMEX y ANUIES debiesen continuar con el desafío. Les invitamos a unirse al intento.

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