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INTERNATIONAL EXTERNAL DISECONOMIES: THE COLORADO RIVER SALINITY PROBLEM IN MEXICO*

FRANCISCO OYARZABAL-TAMARGO** AND ROBERT A. YOUNG***

INTRODUCTION

The problem of dissolved mineral solids (salinity) in the Colorado River waters entering Mexico has been one of the most troublesome issues in U.S.-Mexican relations in recent years. In the early 1960's, a sharp increase in the salinity concentration in Colorado River waters had serious impacts in agricultural productivity in an irrigation district in Mexico.[1] As a result of formal protests by the Mexican Government, a series of agreements were negotiated, and the U.S. undertook measures to reduce the effects of the increased salinity.

In economic parlance, the detrimental effect on downstream Mexican producers is an external diseconomy. An external economy or diseconomy exists when some individual's utility or production relationships include real, nonmonetary variables, the values of which are chosen by other decision-making units without particular reference to the original individual's welfare.[2] Reduced productivity and/or increased costs arising from external diseconomies pose significant problems of efficiency in resource allocation and equity among affected parties.[3] Resolution of such allocation and equity issues is typically a difficult process, and is even less tractable when the emitting and the receiving entities are separated by international boundaries. Effective resolutions of conflicts arising from external diseconomies can be facilitated by quantitative economic measures of the relevant impacts.

We recently developed an estimate of the direct economic damages to Mexican irrigators which would result from various degrees of salinity in the Colorado River. This "damage function" enables the

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[1] Holburt, *International Problems of the Colorado River*, 15 NAT. RES. J. II (1975). Physical, legal and economic aspects of the problem are detailed in the papers in the *International Symposium on the Salinity of the Colorado River*, 15 NAT. RES. J. No. 1 (1975).

[2] W. BAUMOL & W. OATES, THE THEORY OF ENVIRONMENTAL POLICY, ch. 2 (1975).

[3] Mishan, *The Postwar Literature on Externalities: An Interpretive Essay*, 9 J. ECON. LITERATURE 1 (1971).

prediction of direct economic impacts or external diseconomies, in Mexico, resulting from change in water quality caused by water management activities in the United States. This paper discusses the procedures and findings of that research.

ORIGINS OF THE PROBLEM

The Colorado River winds for over fourteen hundred miles from its headwaters in the Rocky Mountains before it discharges into the Gulf of California. As is the case with most rivers in arid lands, the Colorado accumulates dissolved salts in its course to the sea. These salts are picked up from both natural sources, such as surface runoff or salt springs, and man-made sources such as irrigation return flows or municipal and industrial discharge. From a near pristine quality in the high mountains, the mineral concentrations in the waters of the Colorado River reach 800-900 parts per million (ppm) in the lower basin, and still higher levels in Mexico.

Dissolved salts in irrigation water are left in the soil as the water itself evaporates from plants and soil surfaces. High concentration of salts in the soil is detrimental to plant growth, and crop yields can be reduced to unprofitable levels when salts have accumulated after a number of years of irrigation. The effects can be mitigated in some degree by the application of water in quantities greater than that normally required for evapotranspiration so that the water flushes excess salts below the plant root zone. In many cases, the resulting highly saline drainage water will raise the ground water table to the root zone. Removing drainage water is likely to create productivity problems (externalities) for downstream users, unless it can be discharged into the sea.

The United States-Mexico Treaty for Utilization of Waters of the Colorado and Tijuana Rivers and of the Rio Grande,[4] signed in 1944, provides that Mexico is guaranteed an annual quantity of 1.5 million acre-feet (m.a.f.) of the waters of the Colorado River. Neither the quantity nor the quality of the water was an issue until about 1961. Prior to that time, Mexico had received flows well in excess of treaty requirements, which served to dilute saline irrigation return flows from the U.S. to the point that its quality was very near to that of water utilized in California and Arizona.[5]

However, in 1961, the Wellton-Mohawk Division of the Bureau of Reclamation's Gila Project in southwestern Arizona commenced operation of a system of drainage wells which discharged saline water

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[4] 59 Stat. 1219 (1945).

[5] *See supra* note 1. *See also* Brownell & Eaton, *The Colorado River Salinity Problem with Mexico,* 69 AM. J. INT'L L. 255 (1975).

into the Colorado River below the last U.S. diversion point. The drainage water had an initial salinity of 6000 ppm, since much of it was ground water that had been concentrated through re-use throughout the previous years of irrigation. Also in 1961, a reduction in deliveries to Mexico had an impact on water quality. For a period 1951 to 1960, Mexico received, on the average, over 4 m.a.f. per year. Due to the need for storage in Lake Powell, which formed the reservoir for the nearly completed Glen Canyon Dam, the average flow after 1961 dropped to the compact limit, 1.5 m.a.f. As a consequence, the waters delivered to Mexico were degraded to a salinity level in excess of 2000 ppm for a period in 1962 as compared with about 800 ppm in 1960. Acreage of land cropped in the Mexicali Valley fell as marginal lands were abandoned due to decreased yields and as the irrigation district reduced water allotments to cope with the lower supply level. The Mexicali farmers reacted vigorously and formal protests to the U.S. were lodged by the Mexican authorities.

Consequently, a series of agreements were negotiated, and the U.S. undertook measures to reduce the impact of saline return flows. These steps included construction of an extension of the Wellton-Mohawk drain so as to provide Mexico with the option of either bypassing or accepting the drainage waters, and then replacing a portion of the bypassed waters with pumped or storage water in excess of the treaty commitment. As a result of these efforts, the annual salinity concentration dropped to more tolerable levels, reaching about 1200 ppm by 1970 and 1971.

The Mexican Government initiated an extensive program to rehabilitate the irrigation district facilities in response to the reductions in water quantity and quality. Upon its completion in 1975, an estimated $100 million (U.S.) had been spent in lining canals, improving drainage, and consolidating lands served by the system.

Further negotiations were begun in 1971. In 1972 President Nixon assigned former Attorney General Herbert Brownell the task of finding a "permanent, definitive and just" solution to the problem.[6] As a result, an agreement was reached in August, 1973, which was approved by the two presidents and incorporated into Minute 242 of the International Boundary Commission. A key provision requires that the U.S. deliver to Mexico waters with an average annual salinity of not more than 115 ppm (± 30 ppm) above the quality of water diverted at Imperial Dam, the last U.S. diversion point. To implement this provision, the U.S. proposed construction of a major desalting plant for Wellton-Mohawk drainage waters, as well as other tempo-

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[6] *Id.*

rary steps to reduce the impact of Wellton-Mohawk salinity. Pending construction of the desalination facilities, the water quality is being maintained by bypassing Wellton-Mohawk drainage water and substituting upstream stored waters to meet the treaty quota.

Minute 242 assures Mexico a water quality not much different from that of Imperial Dam. However, further agricultural, industrial, and energy development in the Colorado River Basin may raise salinity on both sides of the border.

THE STUDY AREA

The region studied is the area under the jurisdiction of the Water Resources Ministry of Mexico, Irrigation District No. 14, known as the Colorado River Irrigation District. The District is located immediately south of the U.S. border on both sides of the Colorado River, and includes the Mexicali Valley, in the state of Baja California, and the San Luis Valley, in the state of Sonora. For convenience, the entire region will be referred to as the Mexicali Valley.

Water rights are available for 203,000 hectares, or about 500,000 acres, and the system serves about 11,900 farmers. Due to land tenure regulations, the holdings are small and relatively uniform in size. Private property landholdings account for 43 percent of irrigated lands, while "ejido" holdings, which are federally owned, but individually farmed, account for the remainder. The model size for both types of properties is about 20 hectares, or 49 acres. Water is available for only one crop cycle per year for any given landholding.

As elsewhere in the lower Colorado River Basin, the climate is hot and dry. Average rainfall is a little over two inches per year, while potential evapotranspiration is estimated at 92 inches.

Soils are basically Colorado River alluvial deposits, similar to but with somewhat better drainage than those in the Imperial Valley. Heavy soils, with poor internal drainage, comprise about twenty-three percent of the total soils, while medium textured soils with adequate drainage account for the balance.

In addition to surface water supplies from the Colorado of 1.5 m.a.f., about 1.0 m.a.f. is pumped from aquifers, mainly in the northeastern section of the region. (Since ground water is also pumped in Arizona from the common aquifer, a conflict over allocation of these waters is emerging.)

CONCEPTS AND PROCEDURES

Economic damages to producers from degraded water quality result from decreased resource productivity.[7] However, in many instances, alternative production technologies can be employed to mitigate the damage. For example, in the case of increased salinity in irrigation water, larger and more frequent irrigations may be employed to offset increased soil salinity and to reduce yield impacts. Hence a measure of damages which reflects the minimum cost response to changes in salinity is more appropriate than is a simple measurement of the value of crop yield reductions. The willingness to pay to avoid damage from an increment in salinity is taken to be the change in net income of a profit-maximizing producer after he adjusts optimally to that salinity increment.

We estimated regional net farm returns at each of fourteen possible water quality levels to provide points on a curve of net returns to water quality. The regional salinity damage function was then derived by relating predicted net income at various increments in salinity as compared to net income at the selected base salinity level. This process is equivalent to the "change in net income" technique for measuring water supply benefits in which the maximum willingness to pay of affected producers is taken to be the producer's net income with, as compared to without, a public project or program.[8]

Let the regional net agricultural income as related to irrigation water salinity be denoted by

$$(1) \quad Z = Z(C),$$

where Z: regional net income; and
C: salinity concentration of irrigation water.

Then the economic damages arising from saline irrigation water of concentration C, denoted D(C), will be:

$$(2) \quad D(C) = Z(C_0) - Z(C),$$

where C_0: the salinity concentration at damage threshold.

$Z(C_0)$ then represents the maximum regional income with respect to salinity. Points on the relation Z(C) are estimated with a series of linear programming models. For any given quality of water, the programming model selects the crop plan, irrigation frequency, and quantity of water which maximizes net regional income. The procedure was adapted from an approach utilized by Moore, Sun, and

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[7] COST-BENEFIT ANALYSIS AND WATER POLLUTION POLICY (H. Peskin & E. Seskin eds. 1975) [hereinafter cited as Peskin & Seskin]; A. KNEESE & B. BOWER, MANAGING WATER QUALITY: ECONOMICS, TECHNOLOGY, INSTITUTIONS (1968).

[8] Freeman, *A Survey of Techniques for Measuring Benefits of Water Quality Improvement*, in Peskin & Seskin, *supra* note 5. *See also* R. Young & S. Gray, The Economic Value of Water, Concepts and Empirical Estimates, Technical Report, National Water Commission (1972).

Snyder.[9] We now describe briefly the method by which the numerical estimates of damages were obtained.

The production function, relating to the impact of dissolved solids in irrigation on crop yield, is measured in terms of the salinity concentration of the soil solution.[10]

(3) Let $Y = f(W, S|K)$,
where Y : yield of crop per unit land area;
W : quantity of water of specified quality applied per unit land area;
S : index of salt concentration in the soil solution; and
K : all other factors, assumed to be constant.

Soil salinity concentration (S) is determined by the initial soil salinity and quantity and quality of irrigation water.

(4) $S = g(S_0, W, C|K)$,
where S_0: index of initial soil salinity.

Then substituting (4) into (3)

(5) $Y = h(S_0, W, C|K)$

The estimation of yield effects from saline water supplies, represented by equation 5, follows the approach of Robinson.[11]

A ratio of the electrical conductivities of the soil extract to the irrigation water was obtained for each soil type. Assuming a steady-state balance in each soil, the possible influence of irrigation management was taken as a function of the soil layer from which the water is extracted by the crops. Five levels of irrigation water application were analyzed for each crop. The soil salinity value was computed for each irrigation schedule, which permits the decrease in crop yields to be estimated from relationships reported by Maas and Hoffman and by a University of California *ad hoc* committee.[12] The proportions of constituent ions in the Colorado River are assumed to remain constant over the range of salinity studied. (Predicted crop

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[9] Moore, Snyder & Sun, *Effect of Colorado River Water Quality and Supply on Irrigated Agriculture,* 10 WATER RESOURCES RESEARCH 137 (1974). For a critical review of alternative approaches to estimating salinity damages in irrigated agriculture, *see* Young, Nobe & Franklin, *Evaluating Economic Effects of Salinity Abatement Projects in the Colorado River Basin,* in SALINITY IN WATER RESOURCES (J. Flack & C. Howe eds. 1974).

[10] Yaron & Bresler, *A Model for the Economic Evaluation of Water Quality in Irrigation,* 14 AUSTL. J. AGRIC. ECON. 53 (1970).

[11] F. Robinson, Salinity Management Options for the Colorado River, U. Cal. Agric. Exp. Sta., El Centro (1974).

[12] Maas & Hoffman, *Crops Salt Tolerance—Current Assessment,* 103 J. IRRIGATION & DRAINAGE DIV., No. IR2, at 115 (1977); U. Cal. *ad hoc* Committee of Consultants, Guidelines for Interpretation of Water Quality for Agriculture, Agric. Ext. Service, Davis (1974).

yield decrements are less than they might be due to the high gypsum content of Colorado River waters.)

Assumptions

The usual rationality and optimizing conditions from production economic theory are postulated. The conditions necessary for aggregation of linear programming models are assumed to be met.[13] The model is developed to represent the current, post-rehabilitation status of the water distribution and drainage facilities, so that the results are not necessarily representative of the damages which actually occurred at the onset of high salinity immediately after 1960. Prices and production technology which existed in 1975 are assumed. Impacts on regional economic sectors which are indirectly linked to irrigation crop production are not considered, although it is likely that indirect impacts were significant, particularly in the period immediately following the drastic decline in water quantity and quality. Household and industrial impacts also are not accounted for; due to a relatively low consumption rate in those sectors, they are not expected to be large.

Methods

Detailed data about the actual production practices and resource organization were required to develop the models. For primary data on resource organization and production technology, a survey of the Mexicali Valley was carried out during the summer of 1975. Interviews with 189 farmers in the area were obtained. The sample was stratified according to land tenure and soil type.[14]

For purposes of the analysis, the Mexicali Valley region was divided into two sub-regions, reflecting, respectively, medium textured soils with adequate drainage and heavy textured soils with poor drainage. (Crops grown on the latter soil type tend to be more affected by salinity.) Seven crops, which account for 95 percent of the cropped acreage in 1975, are incorporated in the model. They are cotton, wheat, alfalfa, safflower, barley, ryegrass and grain sorghum. Productivity was observed to differ with tenure classes and degrees of mechanization. Therefore, two tenure classes, including private owners and *ejiditarios* (federally owned, but individually farmed) and two mechanization levels were included.

Define $X_{ijk\ell m}$ as the hectares in sub-region i (i=1, 2) used in the

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[13] Paris & Rausser, *Sufficient Conditions for Aggregation of Linear Programming Models*, 55 AM. J. AGRIC. ECON. 659 (1973).

[14] F. Oyarzabal-Tamargo, Economic Impact of Saline Irrigation Water: Mexicali Valley, Mexico (unpublished dissertation, Colo. St. U. 1976).

production of crop j (j=1, 2 . . . . . . 7) with irrigation practice k (k=1, 2 . . . . . 5) under technology level ℓ (ℓ=1, 2) and under tenure class m (m = 1, 2). The form of the linear programming objective function is:

$$(6)\quad Z(C) = \text{Max} \sum_{i=1}^{2} \sum_{j=1}^{7} \sum_{k=1}^{5} \sum_{\ell=1}^{2} \sum_{m=1}^{2} \pi^{c}_{ijk\ell m} \; X_{ijk\ell m}.$$

The constraint equations limit land use by soil type, crop, tenure, and technology, as well as specify water supplies.

The coefficient $\pi^{C}_{ijk\ell m}$ in equation (6) represents net income for a crop activity under particular soil, irrigation level, tenure and technology conditions and water quality C. In general form, with i, j, k, ℓ, m subscripts omitted, it is derived as

$$(7)\qquad \pi^{c} = Y^{c} \cdot P_{y} - \sum_{n=1}^{R} (V^{c}_{r} \cdot P_{v_r}),$$

where Y^c : crop yield per hectare at salinity concentration C, from equation 5;
P_y : price of crop at 1975 prices;
$V_r^{\,c}$: quantity of r^{th} capital and labor input items required at concentration C; and
P : input price at 1975 prices.

π^{c} then represents net return to land, including sunk development costs, water, fixed family labor, and entrepreneurial resources.

The net income and resource requirement coefficients were calculated for each of the fourteen salinity levels from 700 ppm to 2000 ppm. The threshold level for detrimental effects of salinity on crops in the model is estimated to be 700 ppm.

From solutions of the fourteen linear programs, a maximum value of regional net return was obtained, together with optimal acreage of crops, for each salinity level.

RESULTS

Computational results are shown in Table 1. Net income, column 2, decreases with reduced water quality, column 1, by magnitudes identified as damages in column 3. A smooth curve fitted to the points of estimated regional net income as related to salinity is shown in Figure 1, while the smoothed damage estimate is graphed in Figure 2.

Marginal damages per year are approximated from the damage estimates, expressed in pesos per part per million increase in salinity. Marginal damages increase with salinity, ranging from 211,000 pesos

TABLE 1

Projected Net Returns, Damages and Marginal Damages for Alternative Irrigation Water Salinity Levels, Mexicali Valley, 1975

(1) Water Quality (ppm)	*(2) Net Income (10^6 pesos)*	*(3) Damages (10^6 pesos)*	*(4) Marginal Damages (10^3 pesos per ppm)*	*(5) Cropped Area (10^3 hectares)*
700	990.4	–	–	203
800	969.3	21.1	211	203
900	947.4	43.0	219	203
1000	919.7	70.7	277	203
1100	889.5	100.9	302	203
1200	858.5	132.0	311	203
1300	824.7	165.7	337	203
1400	788.9	201.5	358	203
1500	751.0	239.4	379	203
1600	710.4	280.0	406	197
1700	667.7	322.7	427	196
1800	622.4	368.0	453	190
1900	576.3	414.1	461	190
2000	527.7	462.7	486	190

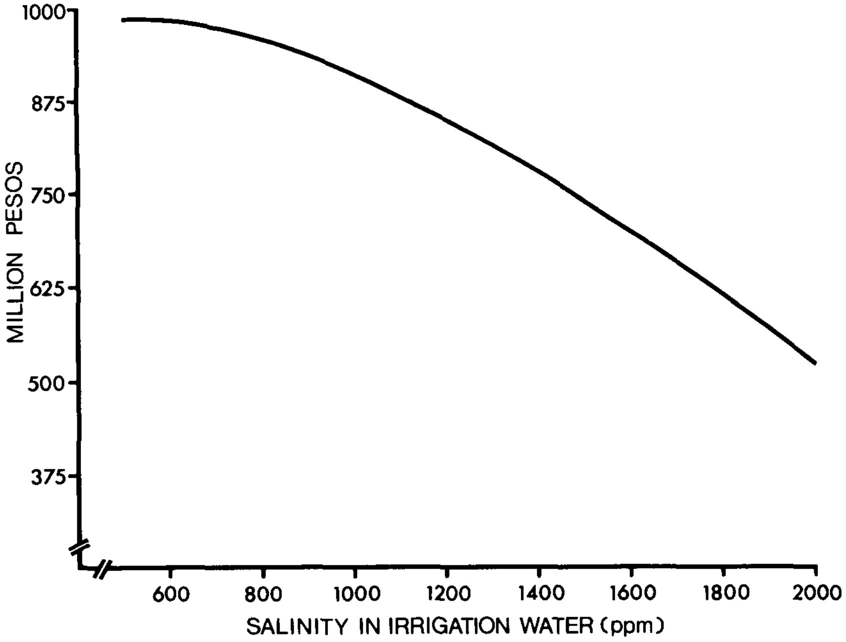

FIGURE 1

Effect of Irrigation Water Salinity on Aggregate Net Income, Mexicali Valley (1975 Prices)

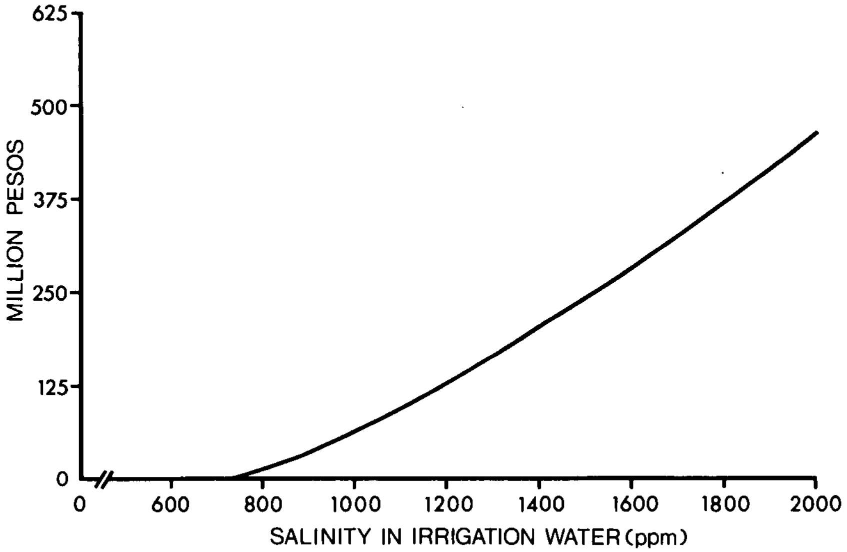

FIGURE 2

Projected Economic Damages From Alternative Salinity Levels, Mexicali Valley (1975 Prices)

per ppm within the 700 to 800 ppm irrigation water salinity range, to 486,000 pesos per ppm in the 1900 to 2000 ppm increment. The average marginal damage over the whole salinity range considered, 700 ppm to 2000 ppm, is 348,000 pesos per ppm. In area terms, the estimated annual marginal damage is 1.71 pesos per ppm per hectare, when salinity is at 1200 ppm.

The linear programs were solved with alternative assumptions regarding land and water supply constraints, and price of cotton. While the aggregate net income function, as represented by Figure 1, was shifted in these cases, the total and marginal damage estimates were relatively unaffected.

QUANTIFYING THE EXTERNALITY

The damage relation whose derivation has been described above could be employed to measure the external diseconomy in the Mexicali Valley of any change in the quality of water in the Colorado River delivered to Mexico. We illustrate the procedure with estimates of the economic effects of saline irrigation return flows from the Wellton-Mohawk Division in western Arizona.

The Wellton-Mohawk drainage system has in recent years discharged an average annual flow of 220,000 acre feet with a total dissolved solids concentration averaging 3,700 ppm.[15] When the drainage system commenced operation in the early 1960's, the drainage water quality was in the neighborhood of 6,000 ppm. Our illustrative calculations attempt to measure impacts at each of these levels.

As noted earlier, since the agreements in Minute 242 have been put into effect, Wellton-Mohawk drainage waters are being by-passed to the Gulf without charge against Mexico's quota. Therefore, the damage estimates described below are hypothetical, in that each attempts to re-create a past situation which hopefully will not recur. Nevertheless, the magnitude of the potential externality is of interest, since some U.S. quarters suspect that the impacts in Mexico were negligible, while some in Mexico are equally convinced that annual damages were immense.

If 220,000 acre-feet of drainage water at 6000 ppm were to be mixed with 1,280,000 acre-feet of Colorado River water of 950 ppm, an increment of nearly 750 ppm to about 1700 ppm is implied. We assume the quality of the ground water used in the District, which comprises some forty percent of the total, is unaffected by the change in river salinity. Using the damage relationship developed in Table 1, the peso value of the externality is given in 1975 prices by

$$\begin{aligned} D(950, 1700) &= .6[Z(950) - Z(1700)] \\ &= .6(933.6 - 667.7) \\ &= 160 \text{ million pesos.} \end{aligned}$$

This estimate understates the actual income reduction incurred, since the damage function developed here is based on conditions after the improved irrigation and drainage systems were installed to cope with increased salinity and reduced water supplies. Also, indirect economic impacts, which would doubtless be large in this regional economy characterized by considerable unemployment and underemployment, are not measured.[16]

Using the more recent experience as the basis for estimating the potential net income reduction, 220,000 acre-feet of water containing 3700 ppm dissolved solids, when mixed with regular flows sufficient to meet the 1.5 m.a.f. compact obligation, would result in an increase of about 400 ppm to about 1350 ppm in the content of deliveries to Mexico. Applying similar reasoning to the estimated damage function of Table 1, the implied net income reduction in the District would be

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[15] Colorado River International Salinity Control Project, Environmental Impact Statement, 74-39 Interior Dec. 24 (1974).

[16] The recent major devaluation of Mexico's currency suggests that the peso was significantly overvalued at the official exchange rate at the time of our analysis in 1975. Assuming the appropriate shadow exchange rate to be 17.5 pesos to the U.S. dollar, the impact measured above amounts to just over nine million dollars per year, in 1975 U.S. dollars.

76 million pesos. This is equivalent to 626 pesos per hectare on the affected farms, those using surface water, or 12,520 pesos per year on the typical 20 hectare farm.[17]

SUMMARY AND CONCLUSION

Releases of saline drainage water from an irrigation district in the United States reduced productivity and income for farmers using Colorado River water for irrigation in Mexico. The ensuing friction has been one of the most serious problems between the two nations in recent years. Agreements signed in 1973 have provided a basis for solutions to the problem. Negotiations leading to the agreement were carried out by both parties without systematic knowledge of the economic magnitudes involved. This paper reports a first approach to quantifying the direct economic impacts of increased salinity on farmers in Mexico. The estimated external cost indicates a considerable loss was imposed on the affected Mexican farmers, and it is clear that the prevention of resumed salt discharges is clearly warranted on the grounds of both efficiency and equity.

We hasten to add that the above conclusion does not imply endorsement of the proposed desalting plant as the most economical solution from the U.S. point of view. Direct compensation for damages to Mexican interests, if politically feasible, could cost less than 25 percent of the expense of desalination. Continuing to bypass Wellton-Mohawk drainage waters, as is the present practice, is also relatively economical, and will continue to be, so long as the marginal value of water in alternative uses remains below about $70.00 per acre-foot (the point of cost equivalence with the proposed desalting process, using 1975 prices). These and other alternatives deserve more serious discussion than they have yet received.[18]

RESUMEN

Niveles de Salinidad del Agua de Riego y Proyección de Daños Económicos en el Valle de Mexicali.

Las aguas de riego conteniendo sólidos disueltos en exceso de 700 partes por millón tienden a inhibir el crecimiento y producción de las plantas.

Dondequiera que se ha practicado la irrigación se han desarrollado

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[17] Converting again to 1975 U.S. dollars at 17.5 pesos per dollar, these estimates are $4.3 million total damages per year, equal to $424 per affected farm, or about $8.60 per affected acre per year.

[18] For a discussion of other alternatives, *see* Kneese, *A Theoretical Analysis of Minute 242,* 15 NAT. RES. J. 135 (1975); Martin, *Economic Magnitudes and Economic Alternatives in Lower Basin Use of Colorado River Waters,* 15 NAT. RES. J. 229 (1975).

problemas de salinidad. Las aguas del Río Colorado son relativamente salinas en comparación con otros grandes ríos del mundo, además, la calidad del agua del Colorado ha disminuido aún más debido al continuado aumento de drenajes salinos asociados al incremento de tierras irrigadas en la cuenca, así como de los efectos de concentración originados por la evaporación de los almacenamientos. Conforme aumenta la salinidad del agua de riego, los usuarios de esta sufren costos adicionales. El último usuario del agua del Río Colorado es el Valle de Mexicali, y es esta área en donde se han hecho sentir los daños más severos.

Después de recorrer sus primeros 2,200 km, las aguas del Río Colorado derivadas en la presa Imperial, alcanzan una concentración de sólidos disueltos totales de 800 a 900 ppm, unos 30 km aguas abajo en el Valle de Mexicali la concentración es de poco más de 1000 ppm. El desarrollo adicional de la agricultura, industria y energía en la Cuenca del Río Colorado puede elevar la salinidad del agua en ambos lados de la frontera.

Ante esta posibilidad se desarrolló una función que relaciona los daños directos en el Valle de Mexicali con varios niveles de salinidad en el agua de riego, a partir de esta función se estimaron los daños marginales a la región que varían desde U.S. $16,900/ppm para el rango de 700-800 ppm en el agua de riego hasta U.S. $39,300/ppm en el rango de 1900-2000 ppm.

Un decremento en la calidad del agua, como el previsto por el U.S.-Bureau of Reclamation par año 2000, significaría un daño en el Valle de Mexicali de aproximadamente 8 millones de U.S. dólares anuales (1975), representando un detrimento por hectárea de cerca de $40. U.S. dólares por año.

Incrementos en la salinidad del agua de riego de la magnitude prevista, significan una pérdida considerable para el agricultor individual del Valle de Mexicali, además se debe considerar que esta sería adicional al costo que implica el aceptar el incremento en salinidad dispuesta en el Acta 242. Al nivel actual de salinidad, la concentración de 121 ppm mayor que la de la presa Imperial, impone un costo a la región de U.S. $2.7 millones anuales, que en términos de costo por hectáres son aproximadamente U.S. $14 y para el agricultor típico representan U.S. $280 anuales.