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Economic evaluation of the "Healthy Water for La Laguna" project

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ABSTRACT
Objective: To identify the costs and benefits attributable to the "Healthy Water for La Laguna" project, quantifying and evaluating them throughout their useful life, with the aim of judging the convenience of conducting this project.
Design/methodology/approach: An Economic-Financial Evaluation was conducted determining the main economic indicators: Internal Rate of Return (IRR), Net Present Value (NPV), and Cost-Benefit Rate (C/B R).
Results: The project "Healthy Water for La Laguna" was profitable given the following indicators: Social Net Present Value of $26'819,451,175 in a horizon of evaluation of 34 years considering a discount rate of 10%, an Internal Rate of Return (IRR) of 35.29%, and a Benefit-Cost Rate of 2.8. In the sensitivity analysis, it was determined that the project shows a low sensitivity to the increase in investment and operation costs. However, it was seen that the variable that could have the most significant impact is that of benefits, since a reduction of more than 64.33% would make the Net Present Value (NPV) lower than zero.
Limitations on study/implications: The one limitation found in the study was the lack of information, since some missing data had to be estimated.
Findings/conclusions: It can be concluded that the execution of the project is essential and necessary to achieve an immediate increase in the consumption of drinking water in the locations covered by the project, in addition to serving as a departure point to improve the quality of the water used and to reduce the impacts of overexploitation.

Keywords: Evaluation, water, sustainability, price.

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INTRODUCTION

The Comarca Lagunera or Lagoon Region, known as La Laguna, is in the central-northern zone of Mexico, on the border of the states of Coahuila and Durango. This region is made up by 15 municipalities, 10 of which belong to Durango (Gómez Palacio, Lerdo, Tlahualilo, Mapimí, Rodeo, Nazas, Simón Bolívar, San Juan de Guadalupe, San Luis del Cordero, and San Pedro del Gallo) and the other five belong to Coahuila (Torreón, San Pedro, Matamoros, Francisco I. Madero and Viesca) (Mazcorro, cited by López López and Sánchez Crispín, 2010).

According to Maeda (2006), the problem of water arsenic poisoning in the Comarca Lagunera region was evident through an epidemiological study carried out in 1963, although its history remounts to at least 1953. This is because of a prolonged drought that

affected the region between 1952 and 1958, which led to the need to extract underground water to satisfy the demands of supply for the community. During the period of 1953 to 1955, 160 cases of people who had epidermoid-basocellular cancer were detected, whose cause was unknown; these patients came from ejidos belonging to the municipalities of Tlahualilo, Mapimí, Francisco I. Madero, and San Pedro. After performing a series of medical studies and field research, the conclusion was reached that an environmental factor was at the origin of this problem.

The municipalities most affected by water arsenic poisoning are Tlahualilo, Francisco I. Madero, San Pedro, Matamoros, and Viesca (Maeda, 2006). This problem extends from these municipalities toward lower areas, including Matamoros, Coahuila, and the main aquifer, as the levels of water decrease. Maeda also suggests that the best way to approach this problem is for the population to stop consuming water with high levels of arsenic (As), that is, to relocate them in areas free of pollution. In addition, he points out that the measures implemented, both physical and chemical, such as solar filters, inverse osmosis plants, and reducing agents such as iron sulfate and flocculants, have not had positive results.

The quandary in the zone related with the low consumption of water from sustainable sources has become a persistent problem because of the absence of alternatives for healthy supply. The lack of alternative supply sources forces the continued extraction of underground water, which increases overexploitation, to keep urban centers functioning despite the risks and costs involved. Furthermore, as water continues to be extracted from the aquifer, it is highly likely for the concentration of arsenic and other salts to exceed the limits allowed for human consumption.

Therefore, it is imperative to carry out projects that increase water production from sustainable and healthy sources, with the aim of improving the quality of life of the population and to avoid placing public health at risk.

According to the project and for this study, the main objective consisted in establishing the infrastructure required to provide enough high-quality and renewable water. The hypothesis set out is that if the non-sustainable sources are partly substituted, that is, incorporating renewable water of good quality (viability of the project "Healthy Water for La Laguna") and water ceases to be extracted from deep wells, the sustainable production will increase.

MATERIALS AND METHODS

An economic-financial evaluation was conducted using an approach based on the model described by Pavón (2012). This analysis evaluated the key economic indicators, which include profitability, the internal rate of return (IRR), the net present value (NPV), and the benefit-cost rate (B/C R), with the purpose of evaluating the viability of this project.

According to what was established in the guidelines for the elaboration and presentation of the cost and benefit analysis of the investment programs and projects (SHCP, 2013), the project is qualified as a project for economic infrastructure, because it is for the construction of fixed assets to supply services in the water sector. Table 1 shows the investment costs in the project.

Table 1. Investment costs of the project.

Concept	Unit	Amount	UP	Annual cost ($ at 2020 prices)	
				without tax	with tax
Aqueduct	m	46,371	57,190	2,651,936,690	3,076,246,560
Storage tanks	m^3	6,000	16,984	101,901,126	118,205,307
Water treatment plant	Lot	1	2,017,036,929	2,017,036,929	2,339,762,838
Diversion plant	Lot	4	7,627,288	30,661,698	35,567,570
Trunk network	Derivations	10	275,627,764	2,756,277,636	3,197,282,057
Land management	Lot	5	562,193	2,810,963	2,810,963
Pumping plant	Lot	1	547,530,460	547,530,460	635,135,334
Supervision	Lot	1	302,438,229	405,267,227	470,109,983
Management of water rights through technical development	Hm3	150	11,773,760	1,766,064,000	1,766,064,000
Total				10,279,486,729	11,641,184,612

Source: Comisión Nacional del Agua, Organismo de Cuenca Cuencas Centrales del Norte.

Table 2 presents the execution programming of the main components of the project. The execution calendar is expressed in years, programming to execute the tasks in a period of four years, from 2021 to 2024.

The project is executed through financing of a federal program, whose origin of the resources can be a contribution of 50% by the state government and the other 50% federal resources, as presented in Table 3.

The useful life period of the project is restricted by the duration of the materials of the infrastructure that will be built. For example, the specifications of the manufacturer indicate that steel piping has a useful life of 50 years. Other components of the infrastructure can have a similar useful life, or at least 50 years in the case of the civil works. Therefore, it is estimated that the system will function adequately during a minimum of 50 years, as long as adequate conditions of operation, maintenance, and replacement of electromechanical

Table 2. Calendar of project investments. Percentages.

Component	2021	2022	2023	2024
Aqueduct	25.0	35.0	25.0	15.0
Storage tanks	20.00	35.00	25.0	20.0
Water treatment plant	10.0	35.0	30.0	25.0
Diversion plant	0	100.0	0	0
Trunk network	10.0	35.0	40.0	15.0
Land management	100.0	0	0	0
Pumping plant	10.0	35.0	25.0	30.0
Supervision	15.0	35.2	31.3	18.5
Management of water rights through technical development	15.9	32.9	51.20	0

Source: Comisión Nacional del Agua, Organismo de Cuenca Cuencas Centrales del Norte.

Table 3. Calendar of project investments.

Program	Origin of investment resources	Input %	2021	Input %	2022	Input %	2023	Input %	2024	Input %	Total
Federal	State	0%	0	59%	2,392,854,527	59%	2,351,083,044	59%	1,076,654,735	50%	5,820,592,306
	Federal	100%	1,763,227,724	41%	1,667,988,874	41%	1,638,871,196	41%	750,504,512	50%	5,820,592,306
	Sum		1,763,227,724		4,060,843,401		3,989,954,241		1,827,159,247		11,641,184,612
Total	State	0%	0	59%	2,392,854,527	59%	2,351,083,044	59%	1,076,654,735	50%	5,820,592,308
	Federal	100%	1,763,227,724	41%	1,667,988,874	41%	1,638,871,196	41%	750,504,512	50%	5,820,592,306
	Sum		1,763,227,724		4,060,843,401		3,989,954,241		1,827,159,247		11,641,184,612

Source: Comisión Nacional del Agua, Organismo de Cuenca Cuencas Centrales del Norte.

equipment are kept. Nevertheless, with the purpose of evaluating the benefits of the project, a useful life of 30 years has been established since the project finalization. Year "0" of the project corresponds to 2021, and the construction period is programmed for the 2021-2024 period, covering a total of four years. Therefore, the horizon of evaluation is extended to 34 years.

RESULTS AND DISCUSSION

The essence of the project analyzed consisted in providing a sustainable supply of high-quality water in sufficient amount for the municipalities of Francisco I. Madero, Matamoros, San Pedro, Torreón, and Viesca in the state of Coahuila, as well as Gómez Palacio, Lerdo, and Tlahualilo in the state of Durango. The project will allow increasing the availability and the consumption of sustainable drinking water in the zone of influence of the project. The social benefits have been determined through the increase in consumption by the population, which has been quantified and valued following the methodologies published by the Center for Preparation and Evaluation of the Projects (CEPEP, 2018) and the National Water Commission (CONAGUA, 2019).

According to Table 4, which details the flow of funds of the project and includes the valuation of the social costs and benefits identified, the project "Healthy Water for La Laguna" proves to be profitable from a social perspective. This is reflected in a Social Net Present Value (SNPV) of 26,819,451,175 pesos during an evaluation period of 34 years, considering a social rate of 10% discount. This rate was established for an Investment Unit through the Oficio Circular number 400.1.410.14.009, with date January 13, 2014.

The effects that the modification of the relevant variables would cause on the main profitability indicators of the project: NPV, IRR and B/C ratio, were evaluated. The effect for different percentage variables was considered, also determining the percentage variation with which the NPV is equal to zero. The results are presented next, with the PV expressed in pesos at social prices of 2020, the IRR in percentages, and the B/C rate is adimensional. For the case of variations in the investment amounts, the project is not very sensitive in this sphere, since when applying increments of 50, 100, and 250%,

Table 4. Summary of the evaluation.

Concept	Unidad	Valor
Evaluation horizon	Years	34
Social discount rate	Percentage	10.0%
PV social investment costs	Pesos	8,943,619,260
PV social operating costs	Pesos	5,930,449,677
PV total costs	Pesos	14,874,068,937
PV gross profit increased consumption	Pesos	41,693,520,112
PV total benefits	Pesos	41,693,520,112
Social net present value (SNPV)	Pesos	26,819,451,175
Social internal rate of return (SIRR)	Percentage	35.29%
PVB/PVC ratio	Without	2.8

Where: Present Value (PV), Social Net Present Value (SNPV), Social Internal Rate of Return (SIRR), and Benefit Cost Ratio (Total Benefits/Total Costs). Source: Prepared by the authors with data from Comisión Nacional del Agua, Organismo de Cuenca Cuencas Centrales del Norte.

the indicators of profitability continued being favorable. When it comes to the dead point analysis, it was determined that an increase higher than 299.9% in the investment amounts would be required for the NPV to be less than zero. When it comes to the analysis with the operation and maintenance costs, it was determined that it is the least relevant variable on the project's profitability.Increases of 50, 100, and 250% were also considered, which remained favorable in every case. When the analysis of indifference was conducted with this variable, it was determined that an increase higher than 452.2% would be required for the NPV of the project to be negative, which shows lower impact of this variable on the profitability of the project. Finally, Table 5 expresses the analysis that considers possible reductions in the generation of benefits, which is mainly conditioned by variations in the demand. That is, if the demand increases (for example, if physical losses increase or if the population grows at a faster rhythm than what was foreseen), the *per capita* consumption decreases and, as consequence, the benefits are reduced. Initially, variations of 10%, 25%, and 50% were considered in the quantification of these scenarios, and the project remains profitable in these cases. However, a negative Net Present Value

Table 5. Effects under assumptions of benefit reduction.

Indicador	−10.00%	−25.00%	−50.00%	−64.33%
VACS	14,874,068,937	14,874,068,937	14,874,068,937	14,874,068,937
VABS	37,524,168,101	31,270,140,084	20,846,760,056	14,874,068,937
SNPV	22,650,099,164	16,396,071,147	5,972,691,119	0
SIRR	31.74%	26.23%	16.36%	10.00%
B/C	2.52	2.1	1.4	1
IRR	30.37%	24.25%	14.04%	8.20%

VACS: VABS: SNPV: Social Net Present Value; SIRR: Social Internal Rate of Return; B/C: Benefit/Cost; IRR: Internal Rate of Return. Source: Prepared by the authors with data from the Comisión Nacional del Agua, Organismo de Cuenca Cuencas Centrales del Norte.

(NPV) was observed when a reduction of more than 64.25% in the generation of benefits was assumed.

CONCLUSIONS

The conclusion can be reached that the execution of the project "Healthy Water for La Laguna" is important for the Región Lagunera, because it supplies healthy water sustainably for the nine most populated municipalities of the Comarca Lagunera, because all the indicators (NPV, IRR, B/C Rate) are positive. The sensitivity analysis shows that if the costs of infrastructure substantially increase, the project will continue to be profitable. Similarly, if the benefits are reduced to slightly over half, the project will continue to be profitable. With the execution of the project, health problems generated by the consumption of water contaminated with arsenic (As) and other metals would be reduced. Likewise, the overexploitation of water tables would be avoided as a result of the substitution with water from other sources, such as superficial water (dams).

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