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RESEARCH

The development and well-being of the population in mining municipalities of the state of Sonora

El desarrollo y bienestar de la población en municipios mineros del estado de Sonora

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Abstract

In recent years, Sonora has stood out in the production of gold and silver, being the only state in Mexico that produces molybdenum, amorphous graphite, and wollastonite (Ministry of Economy, 2020), with mines located in both urban and rural areas. The objective of this study is to analyze the levels of development and well-being of the population in the municipalities that host Sonora's main mining centers as of 2020. First, a municipal socioeconomic development index is estimated using Principal Component Analysis (PCA), and then, to assess the results, it is compared with the well-being indices calculated by the National Council for the Evaluation of Social Development Policy (CONEVAL). The findings reveal that among the municipalities with major mining centers in Sonora, four are classified as having very high socioeconomic development, one in the high stratum, two with low development, and three with very low development. Moreover, half of these municipalities had nearly 40% of their population living in poverty despite having mining activities. This is further confirmed by an inverse relationship between development and well-being indices, which could be improved by reforming policies such as the Mining Fund.

Keywords: Mining municipalities, development, well-being.

JEL Codes: I3, R1, R11

Resumen

En los últimos años Sonora destaca en la producción de oro y plata, siendo el único productor a nivel nacional de molibdeno, grafito amorfo y wollastonita (S. Economía, 2020) teniendo minas en localidades urbanas y rurales. El objetivo en este trabajo es conocer los niveles de desarrollo y bienestar de la población en los municipios que albergan a los principales centros mineros de Sonora para el 2020. Primero se estima un índice de desarrollo socioeconómico municipal mediante ACP y luego, para evaluar los resultados, se compara con los

índices de bienestar calculados por el Consejo Nacional de Evaluación de la Política de Desarrollo Social. Se encontró que en los municipios donde se localizan los principales centros mineros de Sonora, 4 se clasifican con desarrollo socioeconómico Muy Alto, 1 en el estrato Alto, 2 en desarrollo Bajo y 3 con Muy bajo; Por otro lado, la mitad de los municipios tenían casi al 40 % de su población en pobreza a pesar de contar con minería, lo cual se confirma al mostrarse una relación inversa entre los índices de desarrollo y bienestar, los cuales podrían mejorar al reformar políticas como el Fondo Minero.

Palabras clave: Municipios mineros, desarrollo, bienestar.

JEL: I3, R1 y R11

1. Introduction

The 2030 Agenda for Sustainable Development identifies two of the greatest challenges of the 21st century: reducing inequality gaps among the population and transforming productive processes in the pursuit of a development model that harmonizes the relationship between the economy and the environment (UN, 2015). However, heterogeneous development and income inequality remain pressing issues on the agendas of many countries, particularly in Latin America.

In this context, mining plays a significant role due to its economic, social, and environmental impacts both positive and negative especially since it involves the extraction of non-renewable resources. Mexico boasts one of the most renowned and strategic mining sectors globally, which has played a key role in the country's development from colonial times to the present (Cuen, 2022: 18–25). In 2020, mining accounted for 8.3% of the industrial gross domestic product and 2.3% of the national GDP, despite the shutdown caused by COVID-19 and the gradual reintegration that followed in the subsequent months (Ministry of Economy, 2021).

Mexico's vast mineral resources present a great opportunity for further mining development. In recent years, Sonora has gained national importance due to its production of both metallic and non-metallic minerals. It is the country's only producer of molybdenum, amorphous graphite, and wollastonite (Ministry of Economy, 2020). In fact, the states of Sonora, Zacatecas, Chihuahua, Durango, and Coahuila contribute the most to the country's gold and silver production. Sonora hosts the most important gold-producing companies, while Zacatecas leads in silver extraction (El Financiero, 2020).

In the case of Sonora, "the geological-mining potential is broad and favorable, and there remains the possibility of discovering new mineral deposits of economic interest, as there are many geologically prospective zones that justify further exploration, presenting an opportunity to boost mining activity in the state" (Ministry of Economy, 2020:22). This is exemplified by recent lithium discoveries in the state's mountainous region (ibid., 2021).

The growing importance of mineral resources in the 21st century has led to increased investment in the sector, making it crucial to discuss the extent to which extractive activities contribute to development, especially in the communities where these resources are exploited. This raises the question: What has mining contributed in terms of development and well-being to the people of Sonora? The working hypothesis argues that, while mining is an intensive activity aimed at maximizing profits through mineral exports, it has minimal impact on local or municipal socioeconomic transformation and population well-being.

Therefore, the general objective of this study is to assess the levels of socioeconomic development and well-being of the population in Sonora's main mining municipalities, in order to identify which municipalities, exhibit better development conditions and how their populations fare in terms of well-being. Two specific objectives are proposed: 1) to calculate a Municipal Socioeconomic Development Index (IDSEM) and 2) to identify the mining municipalities with the highest and lowest levels of development and well-being.

This introductory section is followed by four additional parts. The second section presents the theoretical framework surrounding mining activity; the third outlines the methodology and data used in the study. The fourth section presents and discusses the results regarding socioeconomic development and population well-being in the main mining municipalities of Sonora. Finally, the fifth section provides the study's conclusions.

2. Theoretical Framework

Two main approaches are recognized in studies on mining activity: classical extractivism and neo-extractivism. These models have been implemented through economic and social policies by various Latin American governments, reflecting the dominant development ideology from the Global North (Veltmeyer & Zayago, 2020).

Classical extractivism refers to activities that intensively use inputs to obtain non-renewable resources demanded globally in the context of globalization (Göbel, 2015; Gudynas, 2015). Examples include mining, oil extraction, and large-scale agriculture high-intensity activities aimed at maximizing profit through exports with little to no local processing.

According to Gudynas (2015), three criteria must be met for an activity to be considered extractivist: 1) High volume and/or intensity of extraction; 2) Resources are unprocessed or minimally processed; 3) At least 50% of the resources are exported. Due to their nature, these processes are among the most environmentally harmful, often requiring intensive use of water and large tracts of land, which are impacted by leachates and gases released during crushing, washing, corrosion, and chemical separation contaminating both soil and subsoil (Mexican Geological Service, 2017).

However, Ramírez (2005) argues that mining per se is not the problem; rather, the issue lies in the purpose of extraction and the way minerals are commodified. The manner in which resources are exploited and how large companies appropriate the surplus value of this activity is crucial. The funds that reach local communities from mining company profits mainly through taxes[1] are minimal and insufficient to offset the environmental damage, let alone to invest in public works or social programs that would significantly benefit mining towns.

Thus, a shift in the development model based on extractive activities is necessary. Neo-extractivism is seen as a variant of classical extractivism, where the state plays a more active role through public policies raising more revenue via stricter tax frameworks and exerting greater control over permits and concessions. This increased state intervention aims to redistribute the generated wealth to mining regions, improving socioeconomic conditions through extractive activity and fostering development in resource-rich areas (Göbel, 2015; North & Grinspun, 2016; Lander, 2014).

In summary, neo-extractivism is an approach that emerged following the deterioration of the neoliberal model globally. It proposes a new way for resource-rich countries to achieve development, as well as an alternative to counter economic and social inequalities and, ultimately, to eradicate the deep-rooted issue of poverty stemming from the inevitable decline of the Washington Consensus (Azamar & Ponce, 2015). However, this series of "progressive" policies has been widely criticized for essentially maintaining a position of subordination to global markets (Acosta, 2013).

Within this theoretical framework lie the new-generation mining projects, which, under public policy guidelines, must incorporate respect for human rights, compliance with environmental legislation, and a commitment to being a driver of local development. In line with the Sustainable Development Goals of the 2030 Agenda (UN, 2015), this contributes to the promotion of a socially and environmentally responsible mining model an approach that has recently begun to be integrated into development plans in Latin American countries.

On the other hand, there is little empirical information on the impacts of mining activity on socioeconomic development understood as the improvement of social and economic conditions at the municipal level. However, there is a vast body of literature on other types of mining-related implications: soil contamination, land dispossession, and productive chain disruptions (Harvey, 2013), which are indirectly linked to local growth and development. Likewise, empirical evidence shows that some communities near mining areas have a high percentage of people living in poverty or experiencing low levels of economic well-being (CONEVAL, 2021). This underscores the relevance of the findings in this study, which are presented after detailing the methodology and data used, as outlined below.

3. Methodology and Data

First, the municipalities hosting the main mining

1 The payments made by Canadian gold-producing mining companies accounted for less than half of one percent of their annual profits, ranging from 0.013 to 0.44 percent (Guevara, 2016).

centers in the state of Sonora were identified, along with those classified as urban according to the National Urban System classification (CONAPO, 2018). Next, the statistical technique of Principal Component Factor Analysis was used to estimate a Municipal Socioeconomic Development Index (IDSEM) for the year 2020. In addition, the analysis incorporates the well-being thresholds calculated by the National Council for the Evaluation of Social Development Policy (CONEVAL, 2020).

The IDSEM for each municipality was calculated based on eleven statistically significant[2] socioeconomic indicators used to measure socioeconomic development (see Table 1). Once the eleven indicators were obtained, the principal component factor analysis technique was applied to transform this set of indicators into a new composite index that offers a more straightforward interpretation of the phenomenon under study (Díaz de Rada, 2002)[3].

Table 1. Specification of Socioeconomic Indicators.

Dimension	Component	Indicator
Social	Education	Average years of schooling in the municipality
		Percentage of the population aged 18 and over with completed high school
	Services	Percentage of households with access to water
		Percentage of households with access to sewage
		Percentage of households with access to electricity
		Percentage of households with flooring other than dirt
		Percentage of households with internet access
		Percentage of people with access to IMSS services
Economic	Economic	Percentage of the municipality's wages relative to the national total
		Percentage of economic units relative to the national total
		Percentage of Gross Total Production relative to the national total

Source: Author's own elaboration based on the 2018 Economic Census and the 2020 Population and Housing Census, INEGI.

2 Out of a database constructed with a total of 30 indicators, only 11 proved to be statistically significant. For the statistical validation of the model, see Cuen (2022).

3 For a detailed explanation of this technique, see Díaz de Rada, Vidal (2002), chapters 1, 2, and 3.

Table 2. Factor Loadings of Variables Measurings Development in the Municipalities.

Indicators	Components	
	1	2
Average years of schooling in the municipality	0.917	-0.108
% of population aged 18 and over with completed high school	0.881	-0.069
% of households with access to water	0.823	-0.216
% of households with access to sewage	0.848	-0.287
% of households with access to electricity	0.807	-0.267
% of households with flooring other than dirt	0.882	-0.284
% of households with internet access	0.925	-0.096
% of people with access to IMSS services	0.733	-0.144
% of total municipal wages relative to the national total	0.724	0.534
% of economicistas units relative to the national total	0.651	0.679
% Gross Total Production relative to the national total	0.736	0.561

Source: Author's own estimation based on socioeconomic indicators and the Principal Component Analysis method.

It is therefore evident that the variables considered are used as indicators of the population's level of development. In this regard, Table 2 shows the weight or factor loading[4], which indicates the influence of each variable on the factor and allows the naming of the factors. This led to identifying the first component as the Municipal Socioeconomic Development Index (IDSEM), as it synthesizes the common variation of the observable variables that were deliberately selected to measure development in each municipality (ibid., 2002).

Table 3 shows that the socioeconomic development index in mining municipalities assumes both positive and negative values. Higher positive values indicated very high municipal socioeconomic development, while very low levels of socioeconomic development in the municipalities were associated with negative values. Thus, for the year 2020, the IDSEM values ranged from a maximum of 2.7040 to a minimum of –1.6772.

4 Factor loadings greater than 0.5 are considered good, those above 0.6 very good, and those above 0.8 excellent (Díaz de Rada, 2002:133).

Table 3. Strata for the Classfication of the Municipal Socioeconomic Development Index (IDSEM), 2020.

Level	Stratum
Very High	[2.7040, 0.8759]
High	[0.8759, 0.0804]
Medium	[0.0804, -0.4515]
Low	[-0.4515, -0.8756]
Very Low	[-0.8756, -1.6772]

Source: Own estimation based on socioeconomic indicators and the Principal Component Analysis method.

On the other hand, to measure well-being, the methodology developed by CONEVAL (2020) for measuring poverty in Mexico is used. This methodology considers two approaches: the social rights approach, measured through indicators of social deprivation that represent individuals' fundamental rights in terms of social development; and the economic well-being approach, measured through the goods and services that can be acquired with the population's monetary resources, represented by the well-being lines.

The social rights approach includes six indicators of social deprivation: 1) Educational lag, 2) Access to health services, 3) Access to social security, 4) Quality and space house, 5) Access to basic housing servics and 6) Access to food. Meanwhile, to measure economic well-being, CONEVAL defined two basic baskets, one for food and one for non-food items allowing for estimates across both rural and urban localities.

Based on these baskets, that well-being[5] lines are determined as follows: 1) The economic well-being line (the sum of the costs of the food and non-food baskets), which identifies the population without sufficient income to purchase the goods and services necessary to meet basic needs, even if they allocated all their income to that end; and 2) The minimum well-being line (equivalent to the cost of the food basket), which identifies the population that, even if they allocated all their income to purchasing food, still could not afford a diet that meets minimum nutritional requirements.

By combining the social rights (social deprivation) and economic well-being (income) approaches, poverty is identified based on the following definitions:: 1) A person is considered to be in poverty when they experience at least one social deprivation and have insufficient income to meet their needs (their income is below the economic well-being line) 2) A person is considered to be in extreme poverty when they experience three or more social deprivations and have insufficient income to purchase the food basket (their income is below the minimum well-being line).

4. Results and Discussion

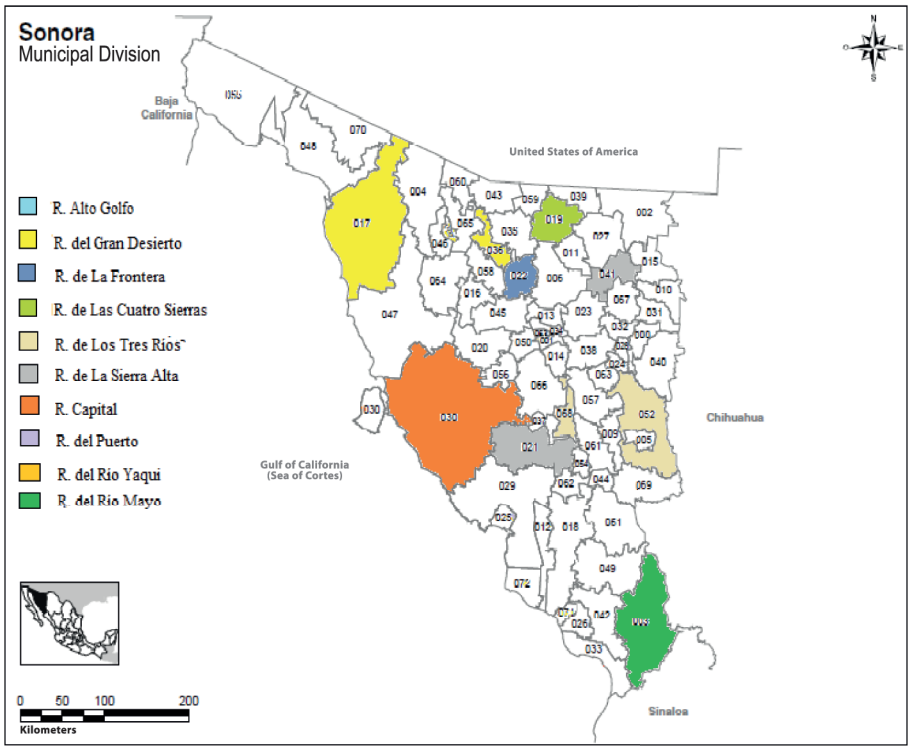
In the 2021–2027 State Development Plan outlines the ten regions that make up the state of Sonora[6] of these, eight regions include municipalities that host at least one of the state's major mining centers (see Map 1 and Table 4). In the Gran Desierto Region: the municipalities of Caborca and Magdalena; in the Frontera Region: Cucurpe; in the Cuatro Sierras Region: Cananea; in the Tres Ríos Region: the municipalities of Sahuaripa and Villa Pesqueira; in the Sierra Alta Region: Nacozari de García; in the Capital Region: Hermosillo; in the Puerto Region: La Colorada; and in the Río Mayo Region: Álamos.

In recent years, mining activity in the state of Sonora has been the most important at the national level. Its production levels in metallic minerals such as gold, copper, and molybdenum, as well as in non-metallic minerals such as graphite and wollastonite, place it in first place nationally. It is also the only producer of molybdenum, amorphous graphite, and wollastonite in the country (Secretary of Economy, 2020). The municipalities of Cananea and Nacozari de García stand out in the production of gold, silver,

5 In 2020, the Urban Wellbeing Line was $3,559.88 and the Rural Wellbeing Line was $2,520.16; while the Urban Minimum Wellbeing Line was $1,702.28 and the Rural Minimum Wellbeing Line was $1,299.30 (Coneval, 2020).

6 The municipalities that make up each region are: Región del Alto Golfo: San Luis Río Colorado, Puerto Peñasco, General Plutarco Elías Calles; Región del Gran Desierto: Caborca, Altar, Sáric, Oquitoa, Átil, Tubutama, Magdalena, Pitiquito, Trincheras, Benjamín Hill, Santa Ana, Carbó; Región de La Frontera: Nogales, Santa Cruz, Ímuris, Cucurpe; Región de Las Cuatro Sierras: Cananea, Naco, Agua Prieta, Fronteras, Bacoachi, Arizpe; Región de Los Tres Ríos: Opodepe, Banámichi, San Felipe de Jesús, Huépac, Rayón, Aconchi, San Miguel de Horcasitas, Ures, Baviácora, Mazatán, Soyopa, Yécora, Villa Pesqueira, San Pedro de la Cueva, Bacanora, Sahuaripa, Arivechi; Región de La Sierra Alta: Nacozari de García, Bavispe, Bacerac, Villa Hidalgo, Huachinera, Cumpas, Huásabas, Bacadéhuachi, Moctezuma, Nácori Chico, Granados, Divisaderos, Tepache; Región Capital: Hermosillo; Región del Puerto: La Colorada, San Javier, Guaymas, Empalme, Suaqui Grande, Ónavas; Región del Río Yaqui: San Ignacio Río Muerto, Bácum, Cajeme; Región del Río Mayo: Rosario, Quiriego, Navojoa, Etchojoa, Benito Juárez, Álamos, Huatabampo. Source https://plandesarrollo.sonora.gob.mx

Map 1. Main Mining Municipalities



Source: Own elaboration based on data from INEGI [www.inegi.gob.mx] and the State Development Plan of the State of Sonora 2021-2027

copper, and molybdenum; Magdalena, Caborca, Sahuaripa, and Cucurpe produce gold; La Colorada produces gold and graphite; in the municipalities of Álamos and Villa Pesqueira, tungsten is produced; and Hermosillo is a producer of wollastonite.

In 2018, the municipalities that most contributed to making Sonora one of the top gold producers in the country were: Caborca 40.54%[7], Cananea 6.10%, Cucurpe 8.46%, La Colorada 3.71%, Magdalena 7.36%, Nacozari de García 3.94%, and Sahuaripa 23%, which together accounted for 93.11% of the total gold production in the state. In copper production, the municipalities of Cananea with 65.52% and Nacozari de García with 20.60% stood out, together contributing 86.13% of the country's total production in 2019[8].

Nacozari de García is the main producer of molybdenum, with 56.94% of the production, and Cananea with 43.06%, which together account for 100% of the national production. Likewise, La Colorada stands out in the production of amorphous graphite, contributing 100% of the state's production. Hermosillo is notable for its production of wollastonite, contributing 100% of the total volume in the state, as well as at the national level.

4.1. Demographic Distribution in the Main Mining Municipalities

Table 4 (2nd and 3rd columns) shows that the municipalities with the main mining centers had a population of 1,146,241 people in 2020, representing 38.9% of the population of Sonora. The population in these municipalities was concentrated hierarchically in Hermosillo (936,263 or 81.68%), Caborca (89,122 or 7.78%), Cananea (39,451 or 3.44%), and Magdalena (33,049 or 2.88%). The remaining six municipalities had a total population of 48,356 residents, distributed as follows: Álamos (2.18%), Nacozari de García (1.25%), Sahuaripa (0.46%), La Colorada (0.16%), Villa Pesqueira (0.09%), and Cucurpe (0.08%).

7 In the municipality of Caborca, the Penmont mining company extracts open-pit gold at Ejido El Bajío. Penmont is a subsidiary of the Fresnillo PLC consortium - a subsidiary of Industrias Peñoles, one of the most powerful not only in Mexico but in Latin America and owned by Alberto Baillères González with a fortune of over $10 billion, according to Forbes.

8 The state of Sonora "has an infrastructure of more than 40 plants for the processing of metallic and non-metallic minerals, which together represent an installed capacity of around 200,000 tons/day, with a current utilization of 90%" (Secretariat of Economy, 2020:35).

Table 4. Sonora. Mining municipalities, population, Socioeconomic Development Index, and Well-being Indexes 2020

Municipalities	Population	%	City/ City Type[1]	IDSEM	Development Level	LBE		LBM	
						People	%	People	%
*Metallic Mineral Production									
26003 Álamos	24,976	2.18	Rural	-0.6027	Low	13,215	52.9	5,540	22.2
26017 Caborca	89,122	7.78	Caborca (3)	0.6552	High	35,328	39.6	9,572	10.7
26019 Cananea	39,451	3.44	Cananea (3)	1.1096	Very High	16,806	42.6	5,058	12.8
26022 Cucurpe	863	0.08	Rural	-1.0442	Very Low	360	41.7	141	16.3
26036 Magdalena	33,049	2.88	M.de Kino (3)	0.8382	Very High	12,298	37.2	3,302	10.0
26041 Nacozari de García	14,369	1.25	Rural	0.9010	Very High	4,130	28.7	911	6.3
26052 Sahuaripa	5,257	0.46	Rural	-0.5800	Low	2,264	43.1	856	16.3
*Non-Metallic Mineral Production									
26030 Hermosillo	936,263	81.68	Hermosillo (1)	2.5170	Very High	292,957	31.3	79,114	8.5
26021 La Colorada	1,848	0.16	Rural	-1.0683	Very Low	469	25.4	139	7.5
26068 Villa Pesqueira	1,043	0.09	Rural	-1.0148	Very Low	281	27.0	100	9.6
Total Mining Municipalities	1,146,241	100.0							

1 According to the classification of the National Urban System (Conapo, 2018): metropolitan areas (type 1), conurbations (type 2), and urban centers (type 3).
Source: Own elaboration based on the 2018 Economic Census and 2020 Population and Housing Census using the Principal Component Method.

Furthermore, it can be seen that the population concentration is linked to the urban dynamics of the state. In this sense, Table 4 (4th column) also illustrates that among these municipalities, there is one metropolitan area[9](Hermosillo) and three urban centers (Cananea, Caborca, and Magdalena), which together account for 95.78% of the population residing in the main mining municipalities. The remaining 4.22% is distributed across six municipalities that are not incorporated into the National Urban System (SUN, 2018), and are therefore purely rural municipalities. However, it is worth noting that the municipality of Nacozari de García is planned to be incorporated as an urban center into the SUN by 2030.

4.2. Municipal Socioeconómico Development

In terms of the Municipal Socioeconomic Development Index (IDSEM), for 2020, Table 4 (5th and 6th columns) shows that there were 4 municipalities that stood out for having the highest positive values in their IDSEM. These municipalities are classified in the Very High Socioeconomic Development stratum: Hermosillo, Cananea, Magdalena, and Nacozari de García. As previously mentioned, the first three are urbanized municipalities with relatively diversified economies, while Nacozari de García is in the process of transitioning from rural to urban according to the National Urban System (SUN, 2018).

Following the highest to lowest positive IDSEM values, the municipality of Caborca is next, placing it in the High Socioeconomic Development stratum. This municipality also contains another urban center (type 3). This positions it as one of the five municipalities with the most favorable conditions to expand the opportunities for its inhabitants in the pursuit of their own well-being, along with the municipalities in the Very High Development stratum.

No municipality shows a Medium Socioeconomic Development level, but there were two municipalities in the Low Development stratum: Álamos and Sahuaripa. Additionally, due to having the highest negative IDSEM values, three municipalities fall into the Very Low Socioeconomic Development stratum: La Colorada, Cucurpe, and Villa Pesqueira. It is clear that these five municipalities are purely rural, and it could be assumed that their main productive activity is mining, which is not reflected

9 In the National Urban System (Conapo, 2018:7), metropolitan zones (Type 1) are characterized by their size and intense functional integration, conurbations (Type 2) by the physical continuity between two or more localities that form a conglomerate, and urban centers (Type 3) are individual localities.

in their municipal socioeconomic development levels.

4.3. Municipal Development and Well-being

When analyzing the socioeconomic development indexes and well-being in the main mining municipalities of Sonora (Table 4, 7th–10th columns), it shows that among the five municipalities with Very High and High IDSEM, three municipalities stand out: Cananea (42.6%), Caborca (39.6%), and Magdalena (37.2%), which had a high proportion of people whose income was not sufficient to reach their economic well-being. It's important to note that the municipalities of Hermosillo and Nacozari de García also approach 30% of their populations in this situation, meaning that at least 3 out of 10 people have an income below the well-being line.

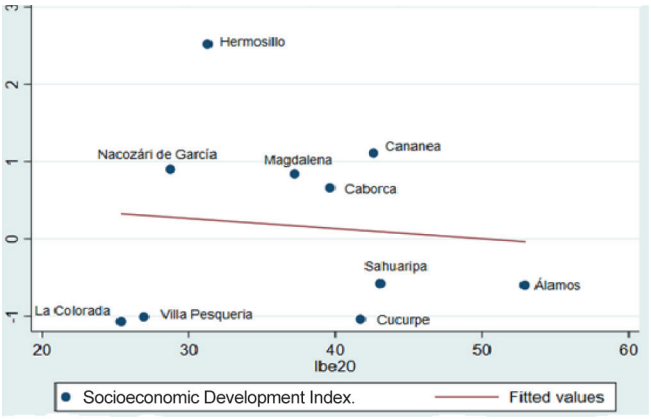
In terms of people whose income does not allow them to acquire a food basket that provides the minimum nutritional requirements, three municipalities stand out: Cananea (12.8%), Caborca (10.7%), and Magdalena (10.0%), followed by Hermosillo (8.5%) and Nacozari de García (6.3%). This implies that among the five municipalities whose IDSEM classifies them in the Very High and High socioeconomic development strata, only the inhabitants of Hermosillo and Nacozari de García enjoy better well-being, as they have the lowest Economic Well-being and Minimum Well-being indexes.

On the other hand, among the five municipalities classified with Very Low and Low socioeconomic development indexes, it is observed that three municipalities show a high percentage of people whose income does not allow them to acquire their economic well-being: Álamos (52.9%), Sahuaripa (43.1%), and Cucurpe (41.7%). These three municipalities also had the highest percentages of people whose income does not allow them to acquire a food basket: Álamos (22.2%), Cucurpe (16.3%), and Sahuaripa (16.3%), followed by Villa Pesqueira (9.6%) and La Colorada (7.5%).

The data from Table 4 allows the creation of Graphs 1 and 2, which show that there is an inverse or negative relationship between the socioeconomic development index of the municipal population and the well-being indexes. In this way, Graph 1 illustrates that as the socioeconomic development index of the municipal population increases, the proportion of people who do not reach their economic well-being decreases. Conversely, as the IDSEM decreases, the Economic Well-being Index (IBE) increases, and therefore, the well-being of the municipal population decreases.

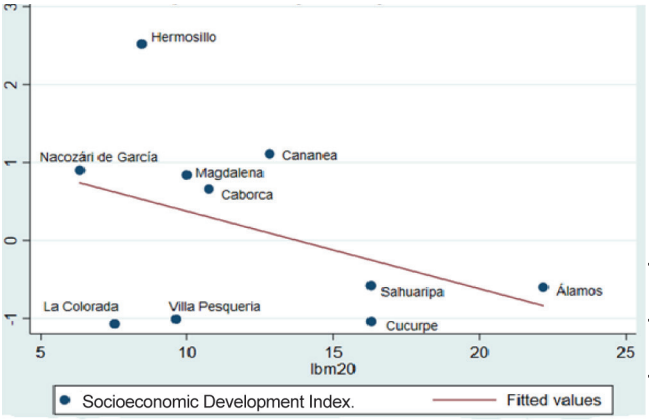
Graph 2 illustrates this trend more clearly. It shows that as the socioeconomic development level increases, the percentage of people whose income does not allow them to acquire the food basket that provides the minimum nutritional requirements for their subsistence decreases, and vice versa. In other words, as the IDSEM increases, so does the well-being of the population in the municipalities (fewer people lack income to acquire the food basket). The municipalities of Hermosillo, Nacozari de García, Sahuaripa, and Álamos are clear examples of the above.

Graph 1. IDSEM and LBE in the Main Mining Municipalities of Sonora, 2020.



Source: Created based on the indices from Table 4.

Graph 2. IDSEM and LBM in the Main Mining Municipalities of Sonora, 2020.



Source: Created based on the indices from Table 4.

In summary, regarding the five municipalities classified in the Very High and High development strata, it can be observed that three municipalities Cananea, Caborca, and Magdalena have around 40% of their population with incomes insufficient to achieve economic well-being. In the other two municipalities Hermosillo and Nacozari de García approximately 30% are in the same situation. Likewise, Cananea, Caborca, and Magdalena have the highest proportions of people whose income does not allow them to afford the basic food basket, followed to a lesser extent by Hermosillo and Nacozari de García.

On the other hand, among the five municipalities with Very Low and Low development, it is noted that two municipalities Sahuaripa and Cucurpe have around 40% of their inhabitants with incomes insufficient to achieve economic well-being. In fact, the municipality of Álamos has 52.9% in this situation, and in La Colorada and Villa Pesqueira, approximately 26% of residents fall into this category. Similarly, Álamos, Sahuaripa, and Cucurpe have the highest proportions of people whose income does not allow them to purchase the food basket, followed by Villa Pesqueira and La Colorada to a lesser extent.

4.4. The Mining Fund: Social Infrastructure and Development

The Mining Fund was a public policy instrument implemented to promote the development of social infrastructure projects in mining municipalities during the period 2014–2017. However, it was discontinued due to operational inefficiencies and alleged corruption, according to the federal administration known as the Fourth Transformation. The allocation of the Fund was based on two criteria: (a) 7.5% of the value of the extractive activity in each municipality, and (b) 0.5% of the revenues from gold, silver, and platinum.

The state of Sonora was the main recipient of Mining Fund resources during the 2014–2017 period. The state received a total of 3,578.7 million pesos from mining activities, which were invested in 382 infrastructure projects across the state (SEDATU, 2019). The ten municipalities considered in this study received a total of 1,894.1 million pesos (Table 5, 4th and 5th columns), accounting for 55% of the total resources allocated during the Mining Fund's active period.

The main beneficiary was the municipality of Cananea, which received a total of 863.0 million pesos (45.6%) invested in 52 social infrastructure projects. This was followed by Nacozari de García, which received 379.62 million pesos (20%) for 50 projects; Caborca, which received 288.9 million pesos (15.3%) for 30 projects; Sahuaripa, which implemented 41 projects with 139.8 million pesos (7.4%); Álamos, which invested 103.2 million pesos (5.4%) in 40 projects; and Cucurpe, which received 78.2 million pesos (4.1%) for 21 infrastructure works.

Table 5. Mining Municipalities, Mining Fund Distribution and Population with 3 or more Social Deprivations.

Municipality	Population	%	Mining Fund Distribution (MF)		≥3 Deprivations		Hypthetical MF Distribution
			In millions	%	People	%	
26003 Álamos	24,976	2.18	103.2	5.4	10,992	8.5	160.2
26017 Caborca	89,122	7.78	288.9	15.3	16,641	12.8	242.6
26019 Cananea	39,451	3.44	863.0	45.6	2,275	1.8	33.2
26022 Cucurpe	863	0.08	78.2	4.1	66	0.1	1.0
26036 Magdalena	33,049	2.88	14.5	0.8	3,267	2.5	47.6
26041 Nacozari de García	14,369	1.25	379.6	20.0	979	0.8	14.3
26052 Sahuaripa	5,257	0.46	139.8	7.4	1,024	0.8	14.9
26030 Hermosillo	936,263	81.68	5.6	0.3	94,327	72.6	1,375.1
26021 La Colorada	1,848	0.16	19.7	1.0	211	0.2	3.1
26068 Villa Pesqueira	1,043	0.09	1.6	0.1	145	0.1	2.1
Total Mining Municipalities	1,146,241	100.0	1,894.1	100.0	129,927	100.0	1,894.1

Source: Own elaboration based on data from SEDATU, 2019

Likewise, La Colorada executed a total of 19.7 million pesos (1.0%) across 11 projects; Magdalena budgeted 14.5 million pesos (0.80%) for 5 projects; Hermosillo implemented 3 projects with 5.6 million pesos (0.30%); and Villa Pesqueira also carried out 3 projects with a total investment of 1.6 million pesos (0.10)[10].

In summary, the distribution of the Mining Fund appears highly inequitable. Of the 1,894.1 million pesos allocated to the ten municipalities included in this study, 82% of the resources were concentrated in those with Very High and High levels of development, particularly in Cananea, Nacozari de García, and Caborca. In contrast, municipalities with Very Low and Low levels of development received only 18% of those resources, with Álamos, Sahuaripa, and Cucurpe being relatively the most benefited among them. This suggests that the Mining Fund favored municipalities in higher development strata, while providing fewer benefits to those in lower development strata-areas that are in greater need of investment due to existing socioeconomic lags.

4.5. Hypothetical Proposal for the Distribution of the Mining Fund

Assuming that the purpose of the Mining Fund was to support projects that expand social infrastructure, a new criterion for allocation could be the number of people with three or more deprivations in each municipality (Table 5, columns 6–8). Based on this criterion, the 1,894.1 million pesos would be distributed as follows: Hermosillo 1,375.1 million (72.6%), Caborca 242.6 million (12.8%), Álamos 160.2 million (8.5%), Magdalena 47.6 million (2.5%), Cananea 33.2 million (1.8%), Sahuaripa 14.9 million (0.8%), Nacozari de García 14.3 million (0.8%), La Colorada 3.1 million (0.2%), Villa Pesqueira 2.1 million (0.1%), and Cucurpe (0.1%).

In addition to the inequity in the distribution of resources, the original two legal criteria that shaped the Mining Fund seem lax: a) 7.5% of the value of the municipality's extractive activity, and b) 0.5% of revenues from gold, silver, and platinum.

A reform could be proposed to the rights law that increases these percentages, as well as changes to the mining sector income tax, concession regulations, and the price per hectare. Why not increase it to 9% of the value of the municipality's extractive activity? Why not 3% of the revenues from gold, silver, and platinum? This, first, considering that higher increases could result in a decrease in private investment; second, also to prevent only the companies from benefiting from the mining activity; and third, primarily to ensure that the population of all municipalities within the regions is benefited, not just the municipality where the mining activity takes place.

5. Conclusions

This study analyzed the levels of development and well-being in the main mining municipalities of Sonora. To do so, a socioeconomic development index was first estimated using the principal components statistical method, followed by the use of well-being thresholds established by the National Council for the Evaluation of Social Development Policy (Coneval, 2021).

The first finding is that municipalities with Very High and High socioeconomic development are those engaged in mining activities and, notably, exhibit some degree of urbanization—such as Cananea, Caborca, Magdalena, Hermosillo, and Nacozari de García which in itself suggests a more diversified economy. According to SUN (2018), Nacozari de García is expected to be classified as an urban center by 2030.

Conversely, municipalities with Very Low and Low socioeconomic development are clearly rural and primarily engaged in mineral extraction. However, this activity does not translate into improved development or well-being for their populationexamples include Álamos, Sahuaripa, La Colorada, Cucurpe, and Villa Pesqueira. This supports the hypothesis of the present study.

A third finding is that among the five municipalities with Very High and High development, only Hermosillo and Nacozari de García simultaneously exhibit better well-being indicators, as they show the lowest values in both the Economic Well-being Index (IBE) and the Minimum Well-being Index (IBM).

10 Another 15 municipalities received a total of $287.45 million pesos to execute 111 additional projects. Moreover, the state government received an allocation of $1,331.11 million pesos, separate from the amounts mentioned above, to carry out a total of 37 infrastructure projects in these or other municipalities with mining activities. In this way, the works were carried out with municipal and state public funds or through collaboration between the two government levels for physical investment (SEDATU, 2019).

It was also found that there is an inverse or negative relationship between the IDSEM and the well-being indices (IBE and IBM). In other words, as IDSEM increases, so does the population's well-being (fewer people fall below economic and food well-being thresholds), and vice versa. The municipalities of Hermosillo, Nacozari de Garcia, Sahuaripa, and Alamos are clear examples.

Furthermore, the inefficient and inequitable allocation of resources from the Mining Fund became evident, as the municipalities with the greatest development lags did not receive the majority of resources. These were instead concentrated in the more developed municipalities. A more equitable criterion would have been to allocate funds based on the number of people with three or more social deprivations.

Lastly, it is essential to amend the tax law, including changes to the income tax law, to enable the state to generate more revenue from the exploitation of important and strategic minerals. The goal is to benefit the population of all municipalities in mining regions not just those directly involved in the activity while maintaining a balance that does not discourage investment. In this way, mining can evolve into an industry that is both environmentally responsible and supportive of productive communities.

References

Acosta, A. (2013). Extractivism and neoextractivism: two sides of the same curse. Beyond Development: Alternative visions from Latin America, 61-86.

Azamar, A., y Ponce, J. I. (2014). Extractivismo y Desarrollo: Los Recursos Minerales en México. Revista Problemas del Desarrollo, 179 (45), octubre-diciembre, 137-158.

CONAPO (2018). Sistema Urbano Nacional 2018. Recuperado de: Sistema Urbano nacional 2018 (sin blancas).indd (www.gob.mx)

CONEVAL (2021). Medición de la Pobreza. Líneas de Bienestar. Recuperado de: Evolución de la Canasta Alimentaria | CONEVAL

Cuen B. (2022). El Desarrollo Socioeconómico de los Municipios Mineros de México. Tesis de Maestría en Desarrollo Regional, CIAD. 1-120.

Díaz de Rada, V. (2002). Técnicas de Análisis Multivariante para Investigación Social y Comercial. Ejemplos Prácticos con SPSS versión 11. Madrid, Editorial Ra-Ma.

El Financiero (2021). Bacadéhuachi, el pueblo de Sonora con el yacimiento más grande de litio en el mundo. Recuperado de: Bacadéhuachi, el pueblo de Sonora con el yacimiento más grande de litio en el mundo – El Financiero

El Financiero (2022). Minería metálica y desarrollo: la oportunidad para el estado de Morelos. Recuperado de:https://www.elfinanciero.com.mx/mundo-empresa/2022/04/28/mineria-metalica-y-desarrollo-la-oportunidad-para-el-estado-de-morelos/

Göbel, B. (2015). Extractivismo y desigualdades sociales. Revista Iberoamericana XV, 58 , 161-165.

Gobierno de Sonora (2021). Plan Estatal de Desarrollo 2021-2027. Recuperado de: https://plandesarrollo.sonora.gob.mx

Gudynas, E. (2015). Extractivismos: Ecología, economía y política de un modo de entender el desarrollo y la Naturaleza. Cochabamba, Bolivia: CEDIB, Centro de Documentación e Información Bolivia.

Guevara G., B. X. (2016). La inversión extranjera directa en la minería en México: el caso del oro. Análisis Económico, vol. XXXI, núm. 77, 85-113.

Lander, E. (2014). El Neoextractivismo como modelo de desarrollo en América Latina y sus contradicciones. Heinrich Böll Stiftung, 11.

North, L. y Grinspun, R. (2016). Neo-extractivism and the new Latin American developmentalism: the missing piece of rural transformation. Third World Quarterly, 23.

ONU (2015). Objetivos del milenio. Recuperado de http://www.un.org/es/millenniumgoals/

Secretaría de Economía (2020). Panorama Minero del Estado de Sonora, 1-75. Recuperado de: http://www.sgm.gob.mx › pdfs › SONORA

Secretaría de Economía (2021). Anuario Estadístico de la Minería Mexicana. Recuperado de: https://www.sgm.gob.mx/productos/pdf/Anuario_2020_Edicion_2021.pdf

SEDATU(2019). Gobierno de México. Obtenido de Fondo para el Desarrollo Regional Sustentable de Estados y Municipios Mineros. Recuperado de: FONDO MINERO - Fondo para el Desarrollo Regional Sustentable de Estado y Municipios Mineros | Secretaría de Desarrollo Agrario, Territorial y Urbano | Gobierno | gob.mx (www.gob.mx)

Servicio Geológico Mexicano (2017). Impacto ambiental. Recuperado de: https://www.sgm.gob.mx/Web/MuseoVirtual/Aplicaciones_geologicas/Impacto-ambiental.html

Veltmeyer, H., & Zayago Lau, E. (2020). Buen Vivir and the challenges to capitalism in Latin America. New York: Routledge.