South American Publishing

SAP Environmental Research and Ecotoxicity. 2024; 3:118
doi: 10.56294/ere2024118

ORIGINAL

Impact of socio-environmental conflicts on mining exports in Peru during the period 2007-2022

Impacto de los conflictos socioambientales en las exportaciones mineras en el Perú durante el período 2007-2022

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Cite as
Acero Flores SM, Hidalgo Lazo KM. Impact of socio-environmental conflicts on mining exports in Peru during the period 2007-2022. SAP Environmental Research and Ecotoxicity. 2024; 3:118. https://doi.org/10.56294/ere2024118

Publication History
Submitted: 02-06-2023
Revised: 09-10-2023
Accepted: 25-04-2024
Published: 26-04-2024

ABSTRACT

The purpose of this research is to examine the impact of socio-environmental conflicts on mining exports in Peru during the period 2007-2022. To achieve this objective, the multiple linear regression method was used, employing the statistical programme SPSS. The results of the analysis showed that, although the model as a whole is significant (calculated p = 0,011 < tabulated p = 0,05), the coefficient for Socio-Environmental Conflicts did not reach statistical significance (calculated p = 0,627 > tabulated p = 0,05). This suggests that the significance of the overall model appears to be due to the intervention of our control variable, regional GDP. This finding highlights the need for more in-depth and detailed research on the relationship between socio-environmental conflicts and mining exports in Peru, considering possible additional factors or alternative methodological approaches to better understand this complex dynamic.

Keywords: Socio-Environmental Conflicts; Mining; Exports; Impact; Mining Investment.

RESUMEN

El propósito de esta investigación es examinar el impacto de los conflictos socioambientales en las exportaciones mineras del Perú durante el período 2007-2022. Para lograr este objetivo, se utilizó el método de regresión lineal múltiple, empleando el programa estadístico SPSS. Los resultados del análisis mostraron que, aunque el modelo en su conjunto es significativo (p calculado = 0,011 < p tabular = 0,05), el coeficiente de los Conflictos Socioambientales no alcanzó significancia estadística (p calculado = 0,627 > p tabular = 0,05). Esto sugiere que la significancia del modelo conjunto parece tener significancia gracias a la intervención de nuestra variable de control PBI regional. Este hallazgo subraya la necesidad de una investigación más profunda y detallada sobre la relación entre los conflictos socioambientales y las exportaciones mineras en el Perú, considerando posibles factores adicionales o enfoques metodológicos alternativos para comprender mejor esta compleja dinámica.

Palabras clave: Conflictos Socioambientales; Minería; Exportaciones; Impacto; Inversión Minera.

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INTRODUCTION

The mining sector, as is well known, has been one of the main drivers of the world economy, and in recent years alone it has been estimated to contribute 45 % of its activity.[1] However, this main source of enrichment for poor countries has generated significant environmental impacts on ecosystems, which is not only a management challenge for society, but also for state institutions, who unfortunately have to ignore the principles of consultation and participation, violating the rights of populations affected by pollution and the loss of their socio-cultural and territorial sovereignty.[2,3]

Likewise, in Peru, the mining sector has driven the development and economic growth of the country, and in 2021 mining exports represented 61,9 % of the total value of exports.[4,5] However, as of August 2022, 209 cases of social conflicts had been registered in Peru, 63,6 % of which were of a socio-environmental nature, 66,9 % of which were linked to mining activities.[6]

In turn, socio-environmental conflicts openly related to mining have become increasingly important in the country since 2005 due to cultural factors and the lack of attention given by the State to this type of problem.[7,8] This growing conflict has had repercussions in the stoppage of mining works such as Las Bambas, which between April 20 and June 15, 2022 , had a loss of US$ 511 million of the total value of exports (COMEX, 2022). Similarly, the stoppage of work at the Cuajone mine resulted in a loss of US$ 253 million.[4,5]

On the other hand, although the government has promoted policies to attract private investment, making the mining sector a strategic and priority for the Peruvian economy, it has not promoted policies of prevention and care for local communities, which has generated socio-environmental conflicts and human rights violations.[9,10] Socio-environmental conflicts refer to situations where the consumption, wear and tear and use of natural resources are strongly intertwined with the effects on local communities that are directly linked to this environment and are manifested when extractive or industrial economic activities cause negative impacts on the well-being, style and rights of local communities.[11,12]

There are several studies that recognize the importance of mining exports in Peru, as well as their great growth over the years, however, this growth has caused serious socio-environmental problems.[7,8,13] Existing literature has identified significant environmental impacts such as pollution and generation of liabilities in ecosystems, as well as a growing socio-environmental conflict linked to distributive problems and disinterest on the part of the state.[7,8,14,15] However, there is a lack of a study or approach to explain the growth and variability of mining exports over the years, the factors involved in their growth and variability, and the influence that socio-environmental conflicts have had on this.

In this context, the main objective of this research is to examine the impact of socio-environmental conflicts on Peruvian mining exports during the period 2007-2022. For a better development and understanding of the topic, the study has been structured in two main subtopics: the differentiated economic impacts of conflicts in the mining sector and the differentiated social and environmental impacts on the affected communities.

This research measures the contribution of the impact of socio-environmental conflicts on mining exports in Peru. In addition, this research contributes to the existing literature in several ways: First, it examines the relationship between the rising socio-environmental mining conflict and the economic impacts that the mining sector may have suffered, such as losses in exports, decrease in investments. Second, by delimiting the literature into 2 main sub-themes, this study provides detailed information on the impact of socio-environmental conflicts in mining, which fills a gap in the previous literature. Third, this longitudinal analysis of almost two decades allows us to capture the temporal evolution of these economic, social and environmental impacts, providing a more complete picture, which provides us with valuable information for decision making and specific public policies to prevent and mitigate such impacts.

The rest of the article is structured as follows: the next part provides the literature review and hypothesis development, the third part of the study explains the methodology, the fourth part provides the empirical results and the last part is the Conclusion and Recommendations.

METHOD

Description of data

The present study measures the contribution of the impact of socio-environmental conflicts on Peruvian mining exports. For this purpose, data on the various variables have been collected and processed:

- Main dependent variable: mining exports.
  - Data in FOB value (million dollars) for copper, zinc and lead.
- Independent variable: Socio-environmental conflicts.
  - Annual average of reported monthly cases.
- Additional dependent variables related to the specific hypotheses:
  - Production Volume: Volume in thousands of metric tons for copper, zinc and lead.
  - Mining investment: Dollar amounts allocated to the sector.
- Control variable (independent): Regional mining GDP.
  - Average mining GDP of the main mining regions: Cusco, Ancash, Moquegua and Apurimac.

Research design

This research is based on a non-experimental design, with a longitudinal and applied approach. The level of research is argumentative.

Population and Sample

The population of our research is the mining exports during the period 2007 to 2022.

The sample of our research is the mining exports of copper, zinc and lead during the period 2007 to 2022. These minerals are the main mining products most exported in the country.

Technique and instrument

The technique to be used in this study is multiple regression analysis, while the instrument used will be the SPSS statistical program.

Type of data

Secondary data sources were used, since the data was collected from government sources.

Data collection

In order to collect the necessary data, we resorted to various official sources:

Mining exports and production volume of copper, lead and zinc.

Source: Mining Yearbook - Statistical Report of the Ministry of Energy and Mines.

Socio-environmental conflicts.

Source: Monthly reports from the Ombudsman's Office.

Processing: Annual averages were calculated from monthly data for the period 2007-2022.

Mining investment:

Source: Archive of Investment Reports and Publications 2000 - April 2024 of MINEM.

Regional mining GDP. Source: National Institute of Statistics and Informatics (INEI).

Data analysis

The data collected were analyzed through a trend analysis and multiple linear regression process using SPSS software.

RESULTS

In this part of the study, we present the empirical results obtained by analyzing the data collected using SPSS statistical software.

Before delving into the analysis of the results, we present figure 1, which contains a summary of the data collected, showing the key figures of our study during the period 2007-2022.

Años	Fob Total Exportaciones Mineras (Cobre, Zinc, Plomo) Millions Of US$	Promedio Conflictos Socioambientales	Inversión En El Sector Minero En US$	Promedio PBI Regional Minero (Apurímac, Cusco, Ancash, Moquegua) Pen
2007	10,791	31	910,799,062	3,948,778.50
2008	9,881	67	1,267,812,661	4,113,701.75
2009	8,284	124	2,290,273,440	4,396,787.25
2010	12,154	124	3,331,554,471	4,425,606.25
2011	14,671	119	6,377,615,364	4,537,633.00
2012	14,658	134	7,498,207,420	4,835,123.50
2013	13,011	143	8,916,547,048	5,454,625.00
2014	11,901	125	8,079,209,701	4,933,245.75
2015	11,223	143	6,869,666,091	5,397,746.50
2016	13,297	128	3,334,835,398	6,463,605.00
2017	17,970	129	3,978,376,467	6,856,586.25
2018	19,058	114	4,961,841,331	6,587,227.25
2019	17,682	92	5,908,494,999	6,395,795.25
2020	16,204	128	4,325,381,262	5,950,352.75
2021	25,263	113	5,263,279,966	6,113,903.75
2022	23,930	134	5,234,590,336	6,153,621.25

Figure 1. Summary of data collected

Continuing with another important point of the results, we analyzed the descriptive statistics of our data presented in figure 1.

These statistics were done with SPSS software and are presented in figure 2. First, we analyze the mining exports. According to the figure, these present an average of 14 998,6119 million US$, which represents the average of exports during the period studied. The range of 16 978,93 million US$ suggests that there is a wide variation in export values. This variability is further evidenced by the minimum value of US$8 284 million and the maximum of US$25 262,93 million, reflecting a large difference between these years. The standard deviation of 4 810,17291 million US$ indicates a considerable dispersion around the mean, emphasizing the volatility of the mining export sector.

Secondly, we examine socio-environmental conflicts. The mean is 115,50, the range is 112, with a minimum of 31 and a maximum of 143 conflicts, showing a significant variation in the incidence of these problems over the years. The standard deviation of 29,430 suggests a moderate dispersion in the number of conflicts.

Third, we examined investment in the mining sector. The mean of 4 909 280 313,56 US$ reflects the average investment. The range is quite wide at US$ 8 005 747 986, with a minimum of US$ 910 799 062 and a maximum of US$ 8 916 547 048, revealing gigantic volatility in investment levels. This variability is confirmed by the high standard deviation of 2 342 699 148,164 US$, which indicates that investment decisions in the mining sector have very significant fluctuations from one year to another.

Finally, we analyzed the regional mining GDP of Apurimac, Cusco, Ancash and Moquegua. The mean is 5 410 271,1875 soles and the range is 2 907 807,75, with a minimum of 3 948 778,50 and a maximum of 6 856 586,25, which shows us notable differences in economic development between these regions over time. The standard deviation is 967 226,84005 and indicates considerable variability in regional GDP.

	N	Rango	Mínimo	Máximo	Media	Desv. estándar
Exportaciones Mineras (Cobre, Plomo, Zinc)	16	16978.93	8284.00	25262.93	14998.6119	4810.17291
Conflictos Socioambientales	16	112	31	143	115.50	29.430
Inversión en el Sector Minero	16	8005747986	910799062	8916547048	4909280313.56	2342699148.164
Promedio PBI Regional (Apurimac, Cusco, Ancash, Moquegua)	16	2907807.75	3948778.50	6856586.25	5410271.1875	967226.84005
N válido (por lista)	16					

Figure 2. Descriptive statistics of the data in SPSS

Modelo	Variables entradas	Variables eliminadas	Método
1	Promedio PBI Regional (Apurimac, Cusco, Ancash, Moquegua) , Conflictos Socioambientales[b]	.	Introducir

a. Variable dependiente: Exportaciones Mineras (Cobre, Plomo, Zinc)

b. Todas las variables solicitadas introducidas.

Figure 3. Input/output variables

Next, we will continue with the analysis of the results obtained from the multiple linear regression performed in SPSS. figures 3, 4, 5 and 6 present the data corresponding to the testing of the general hypothesis, which will be examined in detail.

According to figure 3, the R-squared, which is the coefficient of determination, is 0,498, which means that approximately 49,8 % of the variability in mining exports can be explained by this model. Likewise, the adjusted R-squared is 0,420, this measure shows us that this model explains about 42 % of the variability of mining exports in an adjusted manner.

According to figure 4, the F-value is 6,436 with a significance level (p-value) of 0,011, which is lower than 0,05. This tells us that the model, as a whole, is statistically significant.

According to figure 5, the constant is -2974,284, but it is not statistically significant (p = 0,605). The coefficient for Socio-environmental Conflicts is -17,614, suggesting a negative relationship with mining exports. However, this coefficient is not statistically significant (p = 0,627). The coefficient for Regional Average GDP is 0,004, indicating a positive relationship with mining exports. This coefficient is statistically significant (p = 0,004).

Modelo	R	R cuadrado	R cuadrado ajustado	Error estándar de la estimación	Estadísticos de cambio				
					Cambio en R cuadrado	Cambio en F	gl1	gl2	Sig. Cambio en F
1	.705[a]	.498	.420	3662.61470	.498	6.436	2	13	.011

Figure 4. Model summary

Modelo		Suma de cuadrados	gl	Media cuadrática	F	Sig.
1	Regresión	172674748.259	2	86337374.130	6.436	.011[b]
	Residuo	174391703.256	13	13414746.404		
	Total	347066451.516	15			

a. Variable dependiente: Exportaciones Mineras (Cobre, Plomo, Zinc)

b. Predictores: (Constante), Promedio PBI Regional (Apurimac, Cusco, Ancash, Moquegua) , Conflictos Socioambientales

Figure 5. ANOVAa

Modelo		Coeficientes no estandarizados		Coeficientes estandarizados	t	Sig.
		B	Desv. Error	Beta		
1	(Constante)	-2974.284	5616.440		-.530	.605
	Conflictos Socioambientales	-17.614	35.375	-.108	-.498	.627
	Promedio PBI Regional (Apurimac, Cusco, Ancash, Moquegua)	.004	.001	.744	3.436	.004

a. Variable dependiente: Exportaciones Mineras (Cobre, Plomo, Zinc)

Figure 6. Coefficients

This model explains a moderate amount of the variation in mining exports (49,8 %). Also, the coefficient for Socio-environmental Conflicts of -17,614 suggests a negative relationship with mining exports. This implies that, on average, for each additional socio-environmental conflict, mining exports decrease by 17,614. However, this coefficient is not statistically significant (p = 0,627). The p-value (0,627) for the coefficient of Socio-environmental Conflicts indicates that this result is not statistically significant, that it may be due to chance or that it simply does not have much influence on mining exports, and therefore the null hypothesis that there is no significant impact must be accepted.

Figures 7, 8, 9 and 10 present the data corresponding to the test of specific hypothesis 1, which will be examined in detail.

According to figure 7, the R-squared is 0,417, which means that approximately 41,7 % of the variability in investment in the mining sector can be explained by this model. Likewise, the adjusted R-squared is 0,328.

According to figure 8, the F-value is 4,658 with a significance level (p-value) of 0,030, which is less than 0,05. This indicates that the model, jointly, is statistically significant.

According to figure 9, the coefficient for Socio-environmental Conflicts is 51,804,496,165, suggesting a positive relationship with mining investment. This coefficient is statistically significant (p = 0,015). Likewise, the coefficient for Regional Average GDP is -27,711, indicating a very small negative relationship with mining investment. However, this coefficient is not statistically significant (p = 0,962).

Modelo	Variables entradas	Variables eliminadas	Método
1	Promedio PBI Regional (Apurimac, Cusco, Ancash, Moquegua) , Conflictos Socioambientales[b]	.	Introducir

a. Variable dependiente: Inversión en el Sector Minero

b. Todas las variables solicitadas introducidas.

Figure 7. Input/Output Variables

Modelo	R	R cuadrado	R cuadrado ajustado	Error estándar de la estimación	Estadísticos de cambio				
					Cambio en R cuadrado	Cambio en F	gl1	gl2	Sig. Cambio en F
1	.646[a]	.417	.328	192071220 0.107	.417	4.658	2	13	.030

a. Predictores: (Constante), Promedio PBI Regional (Apurimac, Cusco, Ancash, Moquegua) , Conflictos Socioambientales

Figure 8. Model summary

Modelo		Suma de cuadrados	gl	Media cuadrática	F	Sig.
1	Regresión	3436482985881347 0000.000	2	1718241492940673 4000.000	4.658	.030[b]
	Residuo	4795875962331143 0000.000	13	3689135355639341 100.000		
	Total	8232358948212490 0000.000	15			

a. Variable dependiente: Inversión en el Sector Minero

b. Predictores: (Constante), Promedio PBI Regional (Apurimac, Cusco, Ancash, Moquegua) , Conflictos Socioambientales

Figure 9. ANOVAa

The model jointly is statistically significant and explains 41,7 % of the variation in mining investment. The coefficient for Socio-environmental Conflicts is 51 804 496,165, indicating a positive and statistically significant relationship (p = 0,015) with mining investment. The positive and significant relationship between socio-environmental conflicts and mining investment is striking, since for each additional socio-environmental conflict, mining investment increases by approximately 51,8 million. Based on these results, we can affirm that there is statistical evidence of a significant impact of socio-environmental conflicts on investments directed to the mining sector between 2007 and 2022. However, the pattern of this impact is contrary to what might be expected, since it tells us that the more conflicts, the greater the investment.[14,15,16,17]

Modelo		Coeficientes no estandarizados		Coeficientes estandarizados	t	Sig.
		B	Desv. Error	Beta		
1	(Constante)	-924214740.005	2945318041.558		-.314	.759
	Conflictos Socioambientales	51804496.165	18550844.834	.651	2.793	.015
	Promedio PBI Regional (Apurimac, Cusco, Ancash, Moquegua)	-27.711	564.453	-.011	-.049	.962

a. Variable dependiente: Inversión en el Sector Minero

Figure 10. Coefficients

Finalizing with the discussion of our results, we had the main objective of examining the impact of socio-environmental conflicts on Peruvian mining exports during the period 2007-2022 and it could be found that, the model as a whole has a value (calculated p = 0,011) < tabular p = 0,05), the value of the coefficient of Socio-environmental Conflicts (calculated p = 0,627) > tabular p = 0,05). This gives us to understand that, although the model as a whole is significant, the value of the main coefficient of socio-environmental conflicts (what we want to test) does not have significance. Likewise, the significance of the joint model seems to have significance thanks to the intervention of our control variable regional GDP. Therefore, these results made us accept our null hypothesis that there are no significant impacts of socio-environmental conflicts on mining exports.[18,29,20]

DISCUSSION

Our results find support in the study done by Coayla et al.[14], who point out that, in Peru, environmental impact studies of large copper companies often do not reveal significant negative impacts, such results support our acceptance of the null hypothesis. In turn, the authors noted that mining operations do affect nearby communities, but that there is no official data to support this.[21,22,23,24]

The limitations we have experienced in our research have to do with the lack of data for our variables on a periodic basis, which perhaps could have shown other types of results.

In our research we wanted to provide a study that explains the growth and variability of mining exports over the years, the factors involved in their growth and variability and the influence that socio-environmental conflicts have had on it. This is why we recommend that future research take into account that there may be other factors that explain the variability in mining exports, apart from socio-environmental conflicts, which are not contemplated in this research. The relationship of these variables and the lack of significance of some coefficients deserves further and more detailed investigation.

CONCLUSIONS

The purpose of this research was to examine the impact of socio-environmental conflicts on Peruvian mining exports during the period 2007-2022. After thoroughly examining our data, we were able to conclude that the model as a whole has a value (calculated p = 0,011) < tabular p = 0,05), the value of the coefficient of Socio-environmental Conflicts (calculated p = 0,627) > tabular p = 0,05). This gives us to understand that, although the model as a whole is significant, the value of the main coefficient of socio-environmental conflicts (what we want to test) has no significance. Also, the significance of the joint model seems to be significant due to the intervention of our control variable regional GDP. Our results are supported by a previous study by Coayla et al. who support the acceptance of our null hypothesis. Also, this research was limited by the lack of periodic data that could have given us a different perspective. It is important to note that future research may investigate other factors that may influence export variability.

This study contributes to the literature by providing knowledge on a study that analyzes the growth and variability of mining exports over the years (2007-2022) and determines the influence that socio-environmental conflicts have had on mining exports. Considering the results of this research, it is recommended that future research should better analyze the complex relationship between both socio-environmental conflicts and mining exports, more variables that may have an influence on mining exports could be used and thus determine in a more detailed and complex way their variability.

FINANCING

None.

CONFLICT OF INTEREST

None.

AUTHORSHIP CONTRIBUTION

Conceptualization: Stefany Mariella Acero Flores, Kenny Mishel Hidalgo Lazo.
Data curation: Stefany Mariella Acero Flores, Kenny Mishel Hidalgo Lazo.
Formal analysis: Stefany Mariella Acero Flores, Kenny Mishel Hidalgo Lazo.
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Writing - proofreading and editing: Stefany Mariella Acero Flores, Kenny Mishel Hidalgo Lazo.

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