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Threat of non-metallic mining on the integrity of the Tocuyo River basin, Lara state, Venezuela

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Abstract: There are various conflicts of usage in the Tokuyo River Basin of Lala Prefecture. The contradiction is that in a semi-arid and water scarce area, the soil has many natural resources, among which the most prominent are non-metallic minerals ((NMM), such as silica, the best clay and a series of decorative stones in the country. The public policies of the State and local governments prevail in this territory. They encourage NMM mining, therefore, criticism of an extractivist economy that has historically dominated the country arises. Through an exhaustive documentary review, results show that there are few references to environmental impact studies associated with NMM mining. There is evidence of open-pit mining near rivers and streams, which exposes areas to erosion and sediment production due to the typical erratic rains that affect the Tocuyo, Morere, Diquiva and Curarigua rivers. The promotion of mining activities by economic interests without the independent participation of environmental institutions puts the integrity of the basin at risk. The situation requires the activism of social movements to denounce the impacts that put, among other things, the future availability of water for human consumption and food production at risk.

Key words: non-metallic minerals; Tocuyo river basin; public policies; environmental impact

1 Introduction

Overall, watersheds face many anthropogenic pressures that affect their integrity, such as urbanization, discharge of polluted water, expansion of agricultural boundaries, improper agricultural management, road engineering, and mining, all of which have a necessary impact on the environment for development. The semi-arid region of Lara has a series of areas of impulse for development, and agriculture and animal husbandry are not the only attractive economic sectors for accelerating desertification. Non-metallic mining is also a historic economic attraction that is reflected today in its culture, among other things, in clay archaeological replicas. Not only in cultural terms, clay is also increasingly being mined for the production of blocks, tiles, and industrial raw materials, as well as for the extraction of stones and slabs known as decorative rocks, most of which are building minerals.

As Giménez (2021) expressed in his introduction to the book "*Hope and Other Commentaries on Water*", the way of influencing territories has profound roots. This historian said that during the conquest process, Indian law declared a series of rules and regulations that linked the supply and quality of water to the activities of mining colonies. However, despite the historic statement, territorial conflicts affecting natural capital of water resources continue.

Mining, as a major sector of a country's economy, has raised profound criticisms in terms of environment, especially ecology, as it is a degrading territorial activity, especially one that leads to desertification. IUCN (2009) pointed out

a series of environmental factors affected by non-metallic mining, such as air (air quality); soil (use); surface water (rainwater discharge, streams, rivers); groundwater (aquifer, groundwater level); animals and plants (terrestrial biological communities); the enhance of natural disasters (seismic activity, landslides); socio-economic cultural conditions (community, archaeological, and cultural aspects); landscape and climate. These factors are affected by the generation of solid waste, the generation of liquid waste, the management of dangerous goods, the generation of noise, air emissions and the destruction of ecosystems. The International Union for Conservation of Nature (2009) explains the potential environmental impacts on surface water and groundwater, some of which are: "local changes in rainfall drainage systems; potential pollution of sediment particles (turbidity) or hydrocarbons generated by machinery and equipment" (p: 28).

Regarding the background of non-metallic mineral materials, it is evident that there is no risk of metallic minerals in the northwest of the country, with different types and territorial boundaries within a large economic structure (Rodríguez, 2003). However, Goddard (2007) reviewed the history of the San Jacinto mercury mine in the Baraguá Mountains of Lara State. Although the mercury mine had no obvious economic significance, it had scientific and geological significance, because it was the only place in Venezuela where cinnabar was mineralized.

This panoramic interest in mining activities in semi-arid areas reminds people of the risks faced by immeasurable water sources under water scarcity conditions, as well as the threat this activity poses to the lifespan and quality of national water conservancy projects. The Tocuyo River basin in Lala Oblast has intervened in several of its rivers, and its water conservancy projects are crucial for agricultural and industrial development, as well as achieving water rights for the majority of the state's population. In this sense, the biggest issue raised here is how much people know about non-metallic mining in Lara State and how it affects the integrity of the Tokuyo River Basin. The development of this study is close to the unfinished answer and further research is needed. More issues have arisen during the investigation process. This article has developed four descriptive sections: conditions of vulnerability and main risks of mining in the basin; economic interests in non-metallic mining in the basin; evidence of non-metallic mineral exploitation in the basin; and final reflections.

2 Working methods

The development of this work was inspired by a category called non-metallic mining exploitation in the semi-arid Lara-Falcón, which emerged from the analysis of interviews in the doctoral thesis of Sorondo (2021) as a potential for sustainable development in the western semi-arid of Venezuela. At the same time, the opportunity arose to make a contribution to Volume 4 of *Venezuela's Rivers at Risk* in 2021. In a specific study, people are increasingly paying attention to non-metallic mining in Lara Oblast, with a focus on the territory of the Tokuyo River basin, which is considered a strategic development territory for the Venezuelan state.

Initially, literature reviews were conducted on academic pages, national institutions, local news, and law (Ramos and Paulin, 2014) to generate theoretical references on topics of interest, rather than becoming an artistic state. A review was conducted on keywords such as non-metallic mining, Lara, clay, mining, environmental impact, and the Tocuyo River basin. Due to the limited availability of information, international reference materials for non-metallic mining sites under similar climatic conditions were consulted. To support these findings, satellite images were visually explained on Google Map to locate some references discovered and examine evidence of mining intervention. The GSM to Geographic UTM converter provided in SIGAM (2021) was used to locate mines on the State map. To analyze potential risks, the geomorphic information provided in the *Diagnosis of the Lala State Land Management Plan* (POTEL) used during the 2007-2013 planning period (Lala State Government et al., 2006) was used.

3 Results

There is little or almost no public information on non-metallic mining in Lara State, environmental impact studies are inaccessible, and a list of mining activities cannot be obtained. In this sense, these sources of information are indirectly from works that pointed out the problem of interest, enabling non-metallic mining in Lala State to be linked to the integrity of the basin. The lack of scientific production can also be explained as the result of a crisis in universities and the country, which has affected, inter alia, science and technology, as well as the institutionalization of those who were dedicated to the collection of information in the field.

Entering the topic of this article, it was found that Castillo et al. (2002) mentioned the agenda of mining concession groups, stating that non-metallic mining in Venezuela "...in the academic sphere of higher education in mining, particularly in research, is still pending" (p. 443). In addition to activities that coexist with biological and human communities in the watershed, the impact on it needs to be evaluated. The same author also stated that there was knowledge about potential and obvious cumulative environmental impacts, which was evidenced by business opportunities.

The discovered information is divided into three structures, explaining the vulnerable conditions and lack of environmental concepts of mining activities in the Tokuyo River Basin, understanding the historical economic benefits of non-metallic mining in the basin without environmental concepts, and supplemented by evidence of current mining in the Tokuyo River Basin.

3.1 Vulnerable conditions for mining activities in the Tokuyo River Basin of Lara Oblast

Lala and Falcón share one of the most important basins in the Caribbean Sea. Starting from the Portuguese Mountains, there is a water producing territory. Along the 300 km long route, it covers an area of 172,100 hectares. It is a priority source of agricultural development and human settlements. The Tokuyo River Basin accounts for over 67.5% of the territory of Lala Oblast and has different types of ecosystems, which are determined by rainfall in irregular terrain. Extreme conditions have been observed there, leading to natural and human erosion, resulting in sediment movement. The average rainfall ranges from 380 mm in the Pobaret Mountains to 1,650 mm in the Portuguese Mountains. In most parts of the territory, rainfall is mainly distributed in a bimodal manner. In some cases, up to 83.5% of the rainfall is concentrated in a few months.

The preferred semi-arid condition for this basin is that evaporation exceeds precipitation by 2 to 5 times. In addition, unstable rainfall events (short-term heavy rainfall) occurred on vegetation with low coverage in the region (Ferrer, 2004). Under the aforementioned climatic conditions, Lala Oblast has carried out economic activities, including non-metallic mining. In this sense, the territory remains dry almost all year round, with a negative water balance and occasional heavy rain, leading to soil erosion, especially in areas with low vegetation coverage.

According to Quiñónez and Dal (2008), as of the study date, 43% of the land in Lara Oblast has a risk of water erosion and degradation, which is considered very high (>200 t/ha/year) and high (50-200 t/ha/year). In the above research, they used the Fournier index to determine the aggressiveness of rainfall. Andrade Benitez (2012) used the same index, and Arnodas (1980) proposed a revised index in Torres Municipality. This index determines the ability or force of rainfall to cause erosion. The values of this index in the areas of the Torres municipality showed that almost all of its territory was between medium and high aggressiveness.

According to the above situation, it can be inferred from the rainfall erosion index that since Torres Municipality City accounts for 36% of Lala State, any environmental modification activities carried out in Lala State may generate considerable erosion risks. Ferrer (1981) refers to a department belonging to another zone of the Morel River slope, which is a dense drainage network designed with sub parallel ridges, with temporary runoff conditions in rainy season. Its rugged

terrain makes it a high-risk area facing erosion processes that alter the riverbed through bottom and suspended sediment. Several authors pointed out that for different regions, the existence of turbidity and sediment in rivers would lead to changes in biota, indicating changes in diversity index.

The risk of territorial erosion processes is supplemented by information on soil conditions of different natural areas in El Potel (2007-2013), as shown in Table 1. The analysis conducted here is related to soil types; its depth; landscape type; the percentage of slope and terrain stability; erosion conditions. From the table, it can be seen that most of the territory has class VII soils with use limitations, as well as shallow, unstable, and moderately to severely eroded soil throughout the territory. Everything indicates that mining is not appropriate. Similarly, in Potel's diagnosis, they provided data on desertification areas for each city, ranging from 41% in Iribarren to 55.4% in Urdaneta.

Table 1. Soil characteristics and erosion conditions in natural space of Lala Prefecture

Espacio Natural	Condición y ha.	Suelo		Paisaje	Relieve		Erosión
		Clase	Prof. cm		%	Estabilidad	
Sierra de Baragua	Seco, P. 222.400	VII	0-15	MB	>45	Muy I	Severa
	A Agr. DA 5.600	III	25-50	V	25-45	Muy S	Fuerte a severa
Bobare - Matatere	DA 300.500	VII	25-50	MB-C	25-45	Muy S	Fuerte a severa
Sierra de Portuguesa	CA	VII	25-50	MB	25 a >45	Movimiento en Masa I	
Sierra de Barbacoa	Páramo P. 5.400	VIII	0-25	MA	>45	Muy I	Poca
	P. DA 42.200	VII	25-50	MA	25 a >45	S y Muy I	Si
	P. DA 116.850	VII	0-25	MB	25 a >45	I	Si
	A Agr. 10.200	II-III	>100	V	0-5		
Depresión Central Lara	Seco DA 218.800	VI	>100	D	5	S	Modera a fuerte
	A Agr 156.200	III	>100	D	<5		
	P DA 119.100	VII	0-50	D	10-25	S	Mucha
	Muy degra. P 83.900	VII	5-15	D	25-45	I	Severa
	P	VII		D	5-15		Severa
Jirahara - Ziruma	P. Uso pecuario	VII	5-50	MB-C	25 a >45	Muy I	Severa
	A Agr.	III	>100	V	<5	Inundable	Modera

Data on soil and landmine quantities obtained from the *Lala Territory Management Plan* (Portland, 2006).

Acronyms submitted: Condition: P (stony); Agriculture. (Suitable for agriculture); DA (human degradation); CA (water catcher). Landscape: MB (low mountain); MM (Mountains Moderate); MA (high mountain); C (hill); V (valley); D (depression). Stability: I (unstable); S (sensitive).

Land use conflicts are analyzed primarily in terms of agriculture and animal husbandry. To some extent, it is due to the utilitarian deforestation, let alone mining. However, Olivo (2008) stated that under the *Mining Law* (National Assembly, 1999), the government must pay special attention to manual mining, as well as small-scale mining that "causes serious environmental damage" due to difficulty in control (p. 145). These events occurred within the broad framework of Venezuelan environmental legislation, with Decrees 1,257 and 2,219, as well as Resolution 56, as technical standards attached to the *Environmental Criminal Law* (National Assembly, 2012), "which can be understood as a prediction of the potential liabilities of a mining project, thereby providing the correct definition of the measures to be taken" (Olivo, 2008, p. 143).

Similarly, Pastrán (2018) explains that throughout the existence of environmental law, mining activities are subject to little regulation and lack some form of environmental impact research, "aimed at curbing and controlling erosion issues in arid and semi-arid areas, which are important for ecosystems, people, and the economy" (page 9). Therefore, Table 2

summarizes the background deficiencies of the impact of non-metallic mining in semi-arid regions and other areas unique to Lara Oblast, which corresponds to the general points in academic articles. When it comes to the impact of non-metallic mining in Lala State, it is necessary to monitor and study the ecological and social impacts of economic activities promoted by local governments. As a symbol of the desertification area, Otra Banda (2015) in Hidalgo state pointed out that, among other things, pottery activities (historically known for the production of tiles and bricks) meant the mining activities of the industry, and even led to the disappearance of a small village in the middle of today's desolate area.

Table 2. Background of the damage caused by non-metallic mining in semi-arid areas

Localidad	Mineral	Tipo de daño	Referencia
Río Guasare, estado Zulia	Carbón	Condiciones ambientales e integridad estructural y funcional de los ecosistemas.	José E. RINCÓN. (2017)
Rio Turbio, estado Lara	Arena y Grava	De pauperización del hábitat y biota asociada.	Douglas RODRÍGUEZ-OLARTE, Margenny BARRIOS, Críspulo J. MARRERO y Lué Merú MARCÓ. (2017)
Comunidad de Sainó, municipio Andrés Eloy Blanco	Arcillas	Desertificación, pobreza local, deforestación, perdida de agua en la quebrada, polución de partículas de polvo por las excavaciones y camiones.	Edita GRANADILLO MENDOZA, Martín GARCÍA MONTESINOS. (2010)
Qda. de Sanare, Qda. Los Baños, Qda. Curigua, Qda. la Tigrera. municipio Andrés Eloy Blanco	Materia prima para la industria de cerámica	Consecuencias en el paisaje, pérdida de biodiversidad y el daño irreparable que se le hace al suelo y el ecosistema.	Félix Reinaldo PASTRÁN CALLES. (2018)
Ríos con drenajes a la costa oriental del Lago de Maracaibo	Explotación de minerales no metálicos	Ha provocado la depauperación e incluso la desaparición de varios afluentes que drenan la región. Cambios en la cobertura y uso de la tierra con un aumento de la minería no metálica en 17,75% durante el periodo 2000-2015.	Margenny BARRIOS GÓMEZ, Douglas RODRÍGUEZ-OLARTE y Pedro RODRÍGUEZ BUENO. (2018)
Ríos de Venezuela durante el periodo 2011- 2016	Extracciones de minerales no metálicos por parte de gobiernos locales.	Igualmente, en dicho informe señalan el incumplimiento de la normativa legal, y varios casos asociados a ecocidios en cauces de ríos.	Carelia Rayen HIDALGO LÓPEZ, Adelina COLMENÁREZ GOYO y Duilio TORRES RODRIGUEZ. (2020)

Make it oneself.

When reviewing satellite images, clear evidence of manual mining can be seen in all influential cities in the Tokuyo River basin, which needs to be verified. Fig. 1 shows the map of Lara Oblast, which delineates the Tokuyo River Basin, where some mines are discovered in canyon and river environments, with Table 3 attached. Each case has its own geographical location and UTM, with a total of 34 numbered mines, plus 4 that are very close to other mines. These mines are the most obvious under mining conditions, but there are still many mines that need to be verified between the agricultural and degradation departments. Similarly, some of the locations indicated may correspond to more than one mine.

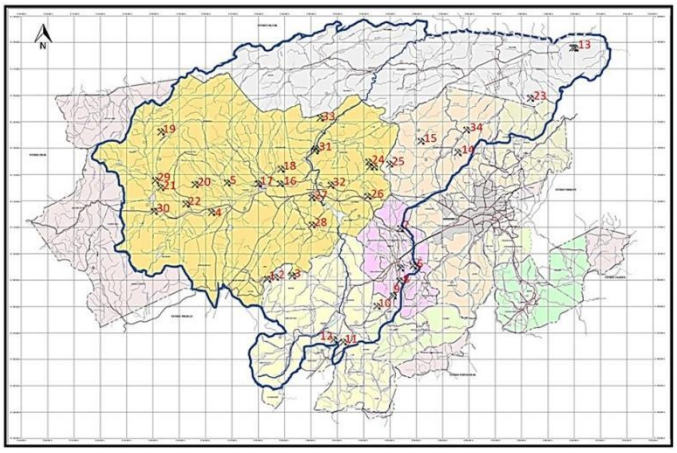

Fig. 1. Location map of some non-metallic mines in the Tokuyo River Basin of Lala Oblast

Source: Topographic map scale 1:250,000, 1:100,000. 1977 Edition. Mar N. National Bureau of Surveying and Mapping.

Table 3. Rivers and canyons irrigated by mining in different cities in the Tokuyo River Basin of Lara Oblast

RÍOS EN RIESGO DEL RÍO TOCUYO	MUNICIPIO	LATITUD LONGITUD	UBICACIÓN UTM 1	UBICACIÓN UTM 2
1. San Pedro. Sub cuenca Río Curarigua	Morán, frontera con el municipio Torres.	9.859973 -70.062314	1090115.6 383519.3	
2. Quebrada La Gruta. Sub cuenca del Río Curarigua	Morán, frontera con el municipio Torres.	9.867745 -70.036190	1090966.0 386386.7	
3. Quebrada Hato Viejo. Sub cuenca Río Curarigua	Morán, frontera con el municipio Torres.	9.876974 -69.974338	1091966.2 393172.1	
4. Burere. Río Quediche. Sub cuenca Río Morere.	Torres. Parroquia Las Mercedes	10.093047 -70.260131	1115966.2 361924.3	
5. Entre quebradas El Cocuy y Aguas Coloradas. Sub cuenca Río Morere.	Torres. Parroquia Trinidad Samuel	10.194176 -70.208012	1127128.3 367677.4	
6. Tintorero. Quebrada Las Raíces del Río Tocuyo	Jiménez. Parroquia Tintorero	9.908998 -69.556355	1095401.9 439008.2	
7. Tintorero. Quebrada Las Raíces del Río Tocuyo	Jiménez. Parroquia Tintorero	10.040829 -69.599191	1109986.6 434338.4	
8. Tintorero. Quebrada Las Raíces del Río Tocuyo	Jiménez. Parroquia Tintorero	9.856066 -69.585511	1089554.8 435801.5	1088172.2 433726.3

9. Quebrada Atarigua afluente de la quebrada Las Raíces del Río Tocuyo	Jiménez. Parroquia José Bernardo Dorante	9.827156 -69.630849	1086367.3 430824.2	
10. Quebrada Atarigua afluente de la quebrada Las Raíces del Río Tocuyo	Andrés Eloy Blanco. Parroquia Tamayo	9.771596 -69.680636	1080234.8 425352.2	
11. Quebrada Guarico. Afluente de río Tocuyo, parte alta de la cuenca.	Morán. Parroquia Guarico	9.649949 -69.787977	1066809.7 413547.8	
12. Quebrada El Cercado. Afluente de río Tocuyo, parte alta.	Morán. Parroquia Anzoátegui	9.654680 -69.828693	1067343.4 409081.7	
13. Quebrada La Pollera. Afluente del río Tocuyo, cuenca oriental.	Urdaneta. Parroquia Moroturo	10.666320 -69.010128	1179084.7 498892.4	1179084.7 500299.8
14. Quebrada Seca. Afluente de río Tocuyo, parte oriental de la cuenca.	Iribarren. Parroquia Aguedo Felipe Alvarado	10.297672 -69.401891	455994.9 1138352.0	
15. Quebrada Matatere. Afluente de río Tocuyo, cuenca oriental.	Iribarren. Parroquia Aguedo Felipe Alvarado	10.327434 -69.496197	445673.7 1141657.3	
16. Quebrada Torres. Afluente del río Morere.	Torres. Parroquia Trinidad Samuel.	10.190140 -70.039232	386165.8 1126617.8	
17. Rio Diquiva. Afluente del río Morere.	Torres. Parroquia Trinidad Samuel.	10.192209 -70.09324	380250.0 1126866.1	
18. Quebrada Torres. Afluente del río Morere.	Torres. Parroquia Chiquinquirá.	10.238614 -70.013923	1131969.3 388955.2	
19. Río Diquiva.	Torres. Parroquia Blanco.	10.365497 -70.430966	1146175.6 343335.6	
20. Río Morere.	Torres. Parroquia Mercedes.	10.097188 -70.311617	1116446.4 356283.7	
21. Rio Diquiva. Afluente del Río Morere.	Torres. Parroquia Mercedes.	10.179772 -70.435718	1125637.1 342723.5	
22. Rio Diquiva. Afluente del Río Morere.	Torres. Parroquia Mercedes.	10.119939 -70.343701	1118976.8 352777.9	
23. Quebrada Los Taturos. Afluente del Río Tocuyo.	Urdaneta. Parroquia Moroturo.	10.484955 -69.150369	1159035.5 483545.2	
24. Quebrada Morrocoy. Afluente del Río Tocuyo.	Torres. Parroquia Reyes Vargas.	10.269543 -69.715161	1135301.5 421685.1	1134791.8 424859.9
25. Sub-cuenca quebrada Bobare. Afluente del Río Tocuyo.	Iribarren. Parroquia Aguedo Felipe Alvarado	10.255890 -69.637409	1133773.9 430196.8	
26. Quebrada Torres. Afluente del Río Tocuyo.	Torres. Parroquia Castañeda.	10.145238 -69.717954	1121557.4 421348.7	

27. Rio Curarigua. Afluente del Río Tocuyo.	Torres. Parroquia Espinoz de los Monteros.	10.138431 -69.909690	1120857.2 400340.6	
28. Rio Curarigua. Afluente del Río Tocuyo.	Torres. Parroquia Antonio Díaz.	10.033721 -69.909090	1109278.5 400374.2	
29. Río Diquiva.	Torres. Parroquia El Blanco.	10.197471 -70.447715	1127600.5 341417.7	
30. Entre embalse Puricare-quebradas El Tablón. Afluente del Río Diquiva.	Torres. Parroquia Las Mercedes.	10.093707 -70.455179	1116128.0 340548.6	
31. Río Tocuyo.	Torres. Parroquia Reyes Vargas.	10.308017 -69.890805	1139603.9 402461.4	1138751.5 401657.8
32. Quebrada Torres. Afluente del Río Tocuyo.	Torres. Parroquia Espinoz de los Monteros.	10.183790 -69.905726	1125871.7 400788.9	
33. Quebrada Las Vegas. Afluente del Río Tocuyo.	Iribarren. Parroquia Aguedo Felipe Alvarado	10.422235 -69.442600	1152130.7 451556.5	
34. Sub-cuenca quebrada Bobare. Afluente del Río Tocuyo.	Iribarren. Parroquia Aguedo Felipe Alvarado	10.380051 -69.370030	1147456.3 459494.1	

Make it oneself.

In all the cities constituting the Tokuyo River basin, there are non-metallic mines. Torres Municipality is the city where the most likely affected mines are found in the Diquiva River, Morel River and Curarigua River sub basins of the Tokuyo River. Similar numbers of mines are also found in the northwest of Iribalun, Jimenez and Morán Municipality. The mine with the largest degradation area is in the city of Shimennis, belonging to the L'Quebrada Los Rotsia basin, which corresponds to the historical clay mining in the state.

3.2 Risks of non-metallic mining without environmental concepts

The lack of environmental impact research in non-metallic mining in Lara Oblast is evident, as is the lack of social participation in project development. In this regard, Martiz (2019) pointed out that in addition to the anarchy in the mining sector, there are many entities that have opaque and erroneous information about their activities and operations. These institutions lack control and follow-up audits, and in practice, the constitutional principle of the National Assembly controlling and approving contracts have not been proven. When the mining owners also dominate the licensing and control agencies, including environmental regulatory agencies that have almost disappeared from the concept of the Ministry of Ecological Mining, the risk increases.

Undoubtedly, mining is related to a series of ecological and social impacts based on economic benefits, and is the cause of excessive habitat dispersion, which accelerates soil erosion and subsequent sediment transport and reduces the service life of reservoirs according to the type of exploitation, water or air pollution, and causes conflicts in the use of territorial space and other economic activities, including those responsible for a country's food sovereignty. In this regard, various benefits arising from the relationship between humans and nature, which may have economic or livelihood purposes, are also discussed.

In addition to these impacts, Häberer (1998) also points out that this activity also leads to landslides, affects the landscape, and often leads to irreversible deterioration. It also damages the living conditions of all biodiversity. For example, waste accumulation can generate pollution that affects water quality and aquatic organisms. Mining, as an

economic activity, has made strong interventions in geological formation, including several stages, all of which start from deforestation to enter the interest layer. This activity itself will cause damage, erosion, and soil pollution, thereby losing its production capacity. Due to unstable rainfall in semi-arid areas, soil is prone to erosion, leading to land degradation. In addition, air pollution caused by dust and exhaust emissions from mines has also had a negative impact on the local climate and changed hydrological patterns.

In this sense, from a socio-economic and ecological perspective, non-metallic mining is a very delicate mining activity that poses a threat to the stability of semi-arid ecosystems due to its high vulnerability and the integrity of river basins and their rivers. Fig. 2 shows two mining scenarios, one corresponds to the historic clay mine in the municipality of Jiménez, which keeps a large part of the Las Raíces stream exposed to erratic rains and consequent erosion. The other is a sector of the Otra Banda that also has historical clay mines for the production of roof tiles and adobe bricks, which is highly desertified.

Fig. 2. Photographic evidence of soil erosion, the upper picture shows the clay mine on the way up to Sanare (Jiménez municipality) and the lower picture shows the clay extraction area for the production of blocks and roof tiles in La Otra Banda (Torres municipality). Make it oneself.

3.3 Economic benefits of non-metallic mining in the Tokuyo River Basin

To understand the risks faced by non-metallic mining in the Tokuyo River Basin, it is necessary to understand the economic benefits associated with this activity. According to Hermann and Zapatini (2014), current mining seems to be a necessary evil, and without minerals, including some fertilizers required for food production, current development cannot be achieved. From the perspective of socio-economic importance, Villas-Bôas and Aranibar (2003) submitted several works, which showed that a large number of Ibero-American territories were affected by artisanal mining and were in conflict with large-scale mining by transnational corporations. This is an economic activity that involves a significant impact on the extraction, development, and utilization stages of surface minerals. Therefore, it is important to stop ignoring

the economic interests of social entities that are immersed in artisanal mining practices and those that move large capitals, both of which cause significant and different environmental impacts.

In Venezuela, mining has been and is being driven by national policies that lead to an increase of exploitations and consequent risks (Galán y Herrera 2017, Martiz 2019). The idea of establishing a mining area by creating business opportunities in the primary production sector began (Castillo et al., 2002), later known as the mining engine. This economic interest pattern is clearly reflected in the national plans, which emphasize that mining is an important component of the national economy and is increasingly receiving attention.

The government's excessive interest in mining originated from the decline in oil prices since 2009, which led to changes in the generation of taxes and the maintenance of tax measures for public institutions. Among other things, this led several states in the country to enact national laws on non-metallic mineral mining between 2009 and 2012 (Bargas, 2017). By 2013, the objectives and strategies of the Venezuelan government appeared, which initiated an intense movement towards what it called "ecological" mining to make it a development pole in order to diversify the national economy (Martiz, 2019).

The national government has formulated more than a dozen laws and decrees during 2016 and 2017 (Machado-Allison and Chernoff 2020) while implementing the mining policies. The statement of Víctor Cano, Minister of Mining and Ecological Development of the People's Power (Minería en Línea, 2018), politically justifies its necessity to act as an input to other economic engines, such as the big Venezuelan mining companies. For Martiz (2019), an administrative procedure has been retained to replace the role of other institutions related to the region, which responds to policies that were arbitrary and biased towards technical requirements.

In 2009, local governments adopted amendments to the *Organic Law on Decentralization, Delimitation and Transfer of Public Power* on the management of natural resources according to special standards, which involves, inter alia, the economic management of non-metallic raw materials (Rodrigues, 2009 and Bargas, 2017). The official website of the People's Ministry of Ecological Mining Development (MPPDME, 2021) lists the following items as decentralized minerals: White Clay, Red Clay, Clays, Sands (Construction), Bentonite, Limestone, Kaolin, Dolomite, Phyllites and Schists, Granite, Magnesite, Marble, Salt, Silica, Talc. This list declares Silica among the "minerals prioritized for the generation of foreign currency from exports", and Phosphate and Limestone among the "minerals prioritized to promote the productive diversification of the national industry". The three mentioned minerals are present in the State of Lara, therefore, in the Tocuyo River basin.

3.4 Non metallic mining in Lara state

Among the various activities carried out during over 500 years of colonization, the geological materials of Lara Oblast are crucial for the indigenous groups that have left their mark in handicraft culture and today's economy. The clay of Lala is reflected in its history as a raw material for making vessels, spiritual rituals, and architecture of different properties. Therefore, it is a territory that has been threatened since its origins with the establishment of agricultural and mining colonies. (Gimenes, 2018).

According to Zozaya (1972), there has been a historic promotion of mining in various sectors of the Tokuyo River basin. The background of the potential for mining to promote development was discussed in 1957 (The 6th Venezuela Engineering Conference held in Valencia), and the first Forum on Nonmetallic Mines (1972) reviewed this issue, which aimed to attract investors. The author reviewed a series of studies on "Venezuelan Industrial Clay Part III" (1966) and supplemented another series of work. In Lala, there is the largest and best quality clay deposit nationwide, which has

attracted people's attention. However, he explained that the mining was insufficient at the time and there were no appropriate technical methods, leading to the collapse of the industry and low quality.

There are no available records with few or no records for non-metallic mining. Additionally, information on existing mines, mining conditions, and mitigation measures published in environmental impact studies cannot be obtained. Even when mines and their impacts are not specified, non-metallic mining is detailed in the national accounts. Despite the references to the ecological fragility of the territory, the POTEL (2006) emphasized mining potential among the economic activities. According to the plan, in 2004 there were 53 companies dedicated to the manufacture of non-metallic mineral products, which represented 9.8% of the total number of companies in the state.

In the diagnosis, they also divided 63 mines in the affected natural space of the Tokuyo River basin according to the type of non-metallic minerals, mainly engaged in the mining of clay (26), gravel and sand (17), followed by Phyllite (10) and other smaller mines. They pointed out the mining potential of the entire Tocuyo River basin and announced the future silica sand mining for that year. Paradoxically, it mentioned violations of environmental laws by the government and private sector, as well as the fact that criminal law had not been applied to violators. This is inconsistent with what Martiz (2019) pointed out about the reduction of mining activity since the 1980s, as a consequence of the emergence of the environmental legal framework in Venezuela.

In 2009, with the support of national policies, the Lala State Government passed the *Lala State Non metallic Minerals Act* (Lala State Government, 2009). According to Galán and Herrera (2017), the so-called non-metallic mineral mining tax stands out among the tax benefits of the country, which is a situation adopted by different states. As a criticism of this procedure of the states, Martiz (2019) explained that "All kinds of illicit acts are committed with the management of non-metallic minerals from the governors' offices. Information was obtained that the governors' offices authorize the extraction of granite, gravel and sand from riverbeds and riverbanks" (p. 90).

The non-metallic mines in Lala Oblast have significant economic significance, and the national government has made them a priority to achieve diversification in the mining industry. Under this economic drive, the government of La Bolivar State established the non-metallic mineral company Hassingto Lala C.A. According to its social networks, together with the National Institute of Geology and Mining (INGEOMIN), they agreed on the quantification and certification of reserves. Likewise, as an action of the Ministry of People's Power for Eco-socialism (MINEC), in their networks they pointed out the payment of fees and collections for permit applications. As actions related to rivers, they mentioned the execution of a calicata (which is counterproductive to environmental actions) and the upcoming dredging of the Dos Cerritos reservoir.

Specifically, in the city of Torres Municipality, they announced the mining of red clay and limestone deposits as the main industries. Mining is considered a link in urban development, but the illegal and unreasonable use of certain non-metallic and forest mineral resources is a threat. By 2013, they had specified the existence of 13 non-metallic mining sites composed of white clay, red clay, silica sand, limestone, sand, and gravel, many of which were used for handicrafts (making traditional folk ceramics) and pottery (rural tiles) (Proinlara, 2013). Extracting these non-metallic minerals in the city is a growing local policy aimed at obtaining economic resources and the investment potential of transforming companies.

By providing decoration and building materials on the free market page (Fig. 3), one way to indirectly observe the economic development around the mining industry in Lala State is through advertising (Fig. 3), which also provides information on all influential cities in the Tokuyo River basin, including photo evidence of mining and exploitations over a decade ago. In addition to these evidence, the mining, processing, and sales industry of non-metallic minerals related to

Cheminet is also very active on international business pages like Granitera Rio Tocuyo; Prali; China Xinhai Group Company homepage. Due to suspicious user usage, some pages are not allowed to continue analyzing.

Fig. 3. (1) Samples of Laja, decorative stone in Jiménez municipality; (2) Laja formateada, Barquisimeto; (3) Laja Piedra Taco, Jiménez municipality; (4) Piedra Taco, Barquisimeto; (5) Adoquín de Arcilla, Torres municipality; (6) Teja Criolla Artesanal-envejecida-arcilla-casa, Barquisimeto.

Source: Mercado Libre, Lara location, March 2021.

The surge in mining activities poses a threat to the situation in the Tokuyo River basin, especially the entire country, while maintaining clear confidentiality of information about relevant entities, making it difficult for people to understand the extent of the impact of this activity on the basin and its rivers. Even though environmental discourse occupies "space" in development projects, in practice, these discourse are ultimately omitted due to economic interests, state and municipal government interests outweighing ecological and social risks, which is contrary to Tamayo's complex thinking. Tamayo explicitly stated in his works that mining was the source of development, but needed to be considered from the perspective of rational use (Giménez, 2018).

3.5 Evidence of non-metallic mineral mining in the state

Although no exact records were found, satellite observations were conducted in Laura State. Through satellite photos, potential interventions and active mines in all cities in the past were identified, as well as areas that require on-site verification. Fig. 4 shows a set of satellite images of some mines with reference to each of the municipalities, showing their proximity to rivers and streams of the Tocuyo river basin with sloping terrain.

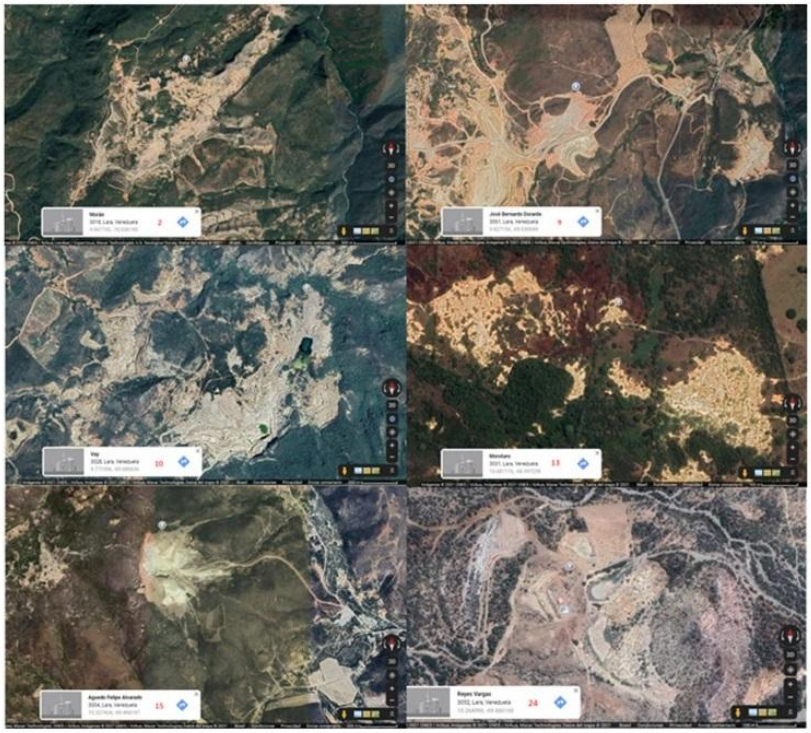

Fig. 4. Satellite evidence of active mines in different cities in Lara Oblast, directly affecting the rivers and canyons of the Tokuyo River basin. Each image corresponds to the data of each city shown in Table 3, with: NO. 2 Moran at 500m scale; NO. 9 Jiménez at 200m scale; NO.10 Andrés Eloy Blanco at 200m scale; NO.13 Urdaneta at 100m scale; NO.15 Iribarren at 500m scale; and NO. 24 Torres at 100m scale.

Source: Google Maps

The mines with numbers 9 and 10 correspond to the historic mines in the Andrés Eloy Blanco and Jiménez municipalities of Lara State, which supply clay to the country's main ceramic industries, as stated in a manifesto published in *Aporrea* in 2009. In this document, they presented a history of land use conflicts with displacement of communities related to part of the territory in the Las Raíces sub-basin of the Tocuyo River basin. The mines with the numbers 13 and 15 of the Urdaneta and Iribarren municipalities respectively correspond to one of the mining interventions of several exploitation focuses in their surroundings, with influence in the Tocuyo river basin.

In the context of environmental conflicts pointed out by the Political Ecology Observatory of Venezuela (OEPVZLA, 2021), since 2017, civil society has been complaining about the local government's activities in mining silica through cooperation with non-metallic mineral company Jacinto Lara and consulting company INESCO with confirmed information on social media at @ minaslara.gob. In this regard, engineer Ramon Rojas told local media that the Los Quedices reservoir may be affected. He continued to say that the source of the Quidditch River would be affected, affecting the supply of water. The communities have declared themselves protectors of the reservoir and feared that more than 400,000 families would be left without water; the communities of Veracruz and La Bárbara have already been fighting against the opening of the mine. The exploitation occurs in the El Plan hill of the "Jirajara formation, which is located in the middle of the cloud forest, where rivers and water sources are born, representing the largest aquifer in the area" (OEPVZLA, 2018).

The silica in this area is an interesting mineral that can be traced back to 1992. In 2016, due to the launch of the "mining engine" as part of the Bolivarian government's economic agenda, interest in mining reignited. This resulted in a 14 year concession granted to Inesco, with the goal of extracting 5.88 million metric tons of silica and constructing roads and

processing plants outside the region. According to the accusations made by the social movement in 2018, the company has proposed progress, development, and assistance, which can help create divisions, contradictions, and social tensions in the affected communities.

4 Final reflections

Considering the integrity of the Tokuyo River basin, it is necessary to understand, inter alia, the complexity of the economy in Lara Oblast and the ecological vulnerability of semi-arid areas. There are clear signs of an increase in the mining of non-metallic minerals in history, and public policies are being implemented to ensure this, which requires attention.

Undoubtedly, this economy in semi-arid regions poses a risk to the stability of ecosystems, especially in the Tokuyo River basin, which is the main source of water for agriculture and cities in the country. However, the above public policy should emphasize that such mining activities may pose ecological and social risks in a territory that is fragile and vulnerable to environmental impacts. Erosion conditions and a high proportion of desertification land, combined with rainfall erosion indices in shallow and medium to high slope soils, are risk conditions for erosion, leading to sediment being dragged into water sources.

Since mining activity seems to be a necessary evil and seems reasonable from a social and economic perspective, it is necessary to deepen the technology of assessment, monitoring and minimizing the impact, and strengthen social control as an early warning measure for the possible impact of this activity. In this sense, territorial development must be considered from a planning and management perspective, with the participation of civil society and independent and transparent institutions that do not obey the interests of private or ideological governments.

Due to the lack of available information, it is necessary to conduct in-depth research on the impact of non-metallic mining on the country and engage in interdisciplinary reflective debates to find forward-looking and feasible solutions. From the perspective of sustainability, it must not be regarded as the possibility of ecological and sustainable mining. It can be envisaged to develop a material recovery economy (circular economy) so that many used minerals can be recycled. These minerals have left an ecological footprint in primary mining. This is mainly because rational use ends up being subjective according to who declares it, in a multidimensionality of factors and interests that determine it.

Non-metallic mining must comply with the environmental legislation that is still in force, and develop technical regulations suitable for semi-arid ecological conditions, where rivers are an important source of balance of nature and territorial sustainability. We face greater risks than protecting our territory, and we need to protect biodiversity, respond to climate emergencies, combat drought and desertification to ensure the integrity of rivers.

Conflicts of interest

The author declares no conflicts of interest regarding the publication of this paper.

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