

CONTENTS

6.3	ECONOMIC VALUATION PROCESS OF ENVIRONMENTAL AND SOCIAL IMPACTS TO BE GENERATED IN THE CONSTRUCTION STAGES AND PROJECT OPERATION	2
6.3.1	<i>Methodology</i>	2
6.3.2	<i>Environmental and social impact identification</i>	3
6.3.2.1	Biotic, Abiotic and socioeconomic impacts analysis.	4
6.3.2.2	Impacts that are not subject to economic valuation.	4
6.3.2.3	Impacts that are subject to economic valuation	11
6.3.2.4	Cost Environmental Benefit Analysis –CEBA.....	14

ILLUSTRATIONS

ILLUSTRATION 6.3-1.	COST ANALYSIS/ENVIRONMENTAL BENEFIT VPN.	16
ILLUSTRATION 6.3-2.	IMPACTS THAT AFFECT POPULATION WELFARE.	18

TABLES

TABLE 6.3-1	MATRIX OF QUALIFICATION RESULTS OF NON INTERNALIZABLE IMPACTS BY PROJECT PHASES.....	3
TABLE 6.3-2.	RESULTS FOR AIR QUALITY PM10.	5
TABLE 6.3-3.	PRODUCTION PROJECTION OF CATTLE IN INFLUENCED AREAS.	12
TABLE 6.3-4.	APPROXIMATE INCOME PROJECTED IN INFLUENCED AREAS.	12
TABLE 6.3-5.	DIRECT EMPLOYMENT GENERATED BY STAGES	13
TABLE 6.3-6.	ESTIMATED PAYMENT OF ROYALTIES IN THE USEFUL PROJECT LIFE.	14
TABLE 6.3-7.	ENVIRONMENTAL COSTS AND BENEFIT ANALYSIS REPRESENTED TO VPN.....	15
TABLE 6.3-8.	CONSOLIDATED NON-INTERNALIZABLE IMPACTS IDENTIFIED	16
TABLE 6.3-9.	CONSOLIDATED NON-INTERNALIZABLE IMPACTS IDENTIFIED ACCORDING TO THE LEVEL.	17

6.3 ECONOMIC VALUATION PROCESS OF ENVIRONMENTAL AND SOCIAL IMPACTS TO BE GENERATED IN THE CONSTRUCTION STAGES AND PROJECT OPERATION

The economic evaluation process of environmental impacts has the aim to present one economic value estimation of benefits and potential environmental costs, which has been considered relevant towards goods flow and services from the influenced area of the project; in the baseline scenario and from a previous perspective. As well as to develop cost environmental benefit analysis and an effective cost analysis of investments in environmental impact control. In such way as to evaluate the efficiency, effectiveness and equity of starting up a mining project.

For that, it is required the definition of non-internalizable impacts, these are impacts that cannot be completely reversed in terms of the generated affect and that are manifested as externalities that cause significant costs for society and threaten to guarantee the sustainability of the natural capital, which are indispensable for the existence of future generations (Ministry of Environment and Sustainable Development and Los Andes University, 2010). Such process requires, as input, the definitive environmental assessment with a view to determine the level of impacts generated by the project.

The internalization of environmental impacts through management measures must accomplish with following criteria, taken from Dixon & Pagiola (1998) and the OCDE (2002):

- The temporal and spatial predictability of the biophysical change.
- The high certainty and accuracy in the prevention or correction measures of such impacts.
- The programs or measures contemplated to carry out the correction must have an effective of 100%, as much as possible.

In the case that some of this conditions stop being fulfilled, such impact will be included or categorized as non-internalizable impact, for which an economic valuation of the impact will be carried out by methods of revealed preferences or declared preferences.

6.3.1 Methodology

The analysis of environmental (Biotic and Abiotic) and social economic impacts that were identify in the Environmental Impact Study, described in the project, will be developed as a criteria of classification. The environmental and social component over which the impacts will be analyzed are generated over it (considering project stages) and its relation with the local population welfare. Likewise, it is justified if the impacts will be submitted to the economic valuation process or not, discarding those impacts that constitute risks and expectations.

6.3.2 Environmental and social impact identification

The Table 6.3-1 presents the results of the impact rating, which reflects the existence of 22 impacts considered as non-internalizable, that is, impacts that obtained a low, moderate or high environmental rating with an incidence of positive (+) or negative (-) impact in accordance to the context; the above in order to get an analysis from each project stage (Construction and Assembly, Production, Closing and Abandonment).

Table 6.3-1 Matrix of qualification results of non-internalizable impacts by project phases.

Area	Non internalizable impacts	Construction and assembly	Operation	Closing and abandonment
Abiotic	Geoform alteration	Low (-)	Moderate (+)	N.A*
	Generation of mass removal processes	Moderate (-)	High (-)	High (-)
	Change in the available resource flow (water supply)	Moderate (-)	Moderate (-)	Moderate (+)
	Alteration of the physical-chemical and microbiological quality of water	Moderate (-)	Moderate (-)	Moderate (+)
	Change in the concentration of particulate matter, gases and vapors in the air	Low (-)	Low (-)	Moderate (+)
	Change in the sound pressure levels	Low (-)	Low (-)	Moderate (+)
	Change in the land use	Moderate (-)	Moderate (-)	N.A*
	Alteration of the physical-chemical and biological properties of the soil	Moderate (-)	Moderate (-)	N.A*
Biotic	Vegetation cover modification	High (-)	High (-)	Moderate (+)
	Ecosystem fragmentation	High (-)	High (-)	Moderate (+)
	Loss of floristic diversity	High (-)	Alto (-)	Low (+)
	Fauna displacement	High (-)	Moderate (-)	Low (+)
	Alterations in behavioral parameters in the fauna.	Moderate (-)	Moderate (-)	Moderate (+)
	Run over fauna	Moderate (-)	Moderate (-)	Moderate (+)
Socioeconomic	Change in migratory flows	High (-)	High (-)	Low (-)
	Variation in the population distribution and location.	High (+)	High (+)	High (-)
	Alterations in population dynamics	High (+)	High (+)	High (-)
	Increase towards means of transport and infrastructure occupation demand.	High (+)	High (+)	High (-)

	Modification in landscape structure	High (-)	High (-)	N.A*
	Generation of employment	High (+)	High (+)	High (-)
	Increase in economic strengthening	High (+)	High (+)	High (-)
	Alteration of the archaeological heritage	Low (-)	Low (-)	N.A*

Significance of impact: Low, Moderate, High.

Impact type: Positive Impact (+) Negative Impact (-)

N.A*: Not Applicable

Source: Ingex, 2015.

As was explained in the methodological section, the economic assessment, of those impacts, is made from methodologies of market prices (change in the productivity), cost avoidance method, replacement cost method, mitigation cost method; which allows to establish costs over environmental goods and their associated ecosystem services, through direct and indirect use values and non-use values.

6.3.2.1 Biotic, Abiotic and socioeconomic impacts analysis.

It is evaluated the environmental impacts relation with human welfare. In this case, only the change or variation of the welfare of the third agent is analyzed; it means, the one who could be affected (negative impact) or benefited (positive impact) by the externality, in case there was. For instance, the possible effects on the company staff who do not constitute a "third agent" are not considered.

In the same way, just imminent environmental impacts are considered due to its occurrence is practically assured, discarding those whose probability of occurrence tends to zero, that is, impacts that constitute risks.

On the other hand, the economic valuation process of identified impacts was carried out in 2014, which have been classified into two groups, the first is formed by those that will not subject to economic valuation since its effects lack significance in human well-being. Second group is formed by impacts that are subject to economic valuation.

6.3.2.2 Impacts that are not subject to economic valuation.

6.3.2.2.1.1 Change in the concentration of particulate matter, gases and vapors in the air.

This environmental impact is generated mainly during the construction and assembly stage of necessary infrastructure for mining activities developing and throughout the operation of it. It is due to the transit of heavy vehicles, transport of sterile material, operation and / or extraction of material in open pit mining.

The obtained results in the modeling indicates that in the course of each one of the stages and/or several scenarios which were planting (short, medium and long term) there are values ranging from 15 - 0.3 $\mu\text{g}/\text{m}^3$ for the short-term PM10 model, for medium term was 40 – 0,3 $\mu\text{g}/\text{m}^3$ and for long term 25 - 0.5 $\mu\text{g}/\text{m}^3$. In case of PST model, the following values are found: for short term 80 - 5 $\mu\text{g}/\text{m}^3$, medium term 200 - 5 $\mu\text{g}/\text{m}^3$ and for long term 80 - 5 μ .

Therefore, it is verified that the values are within the permissible ranges and of low significance due to the implementation of mitigation measures, proposed in the Environmental Management Plan (hereinafter EMP). The Table 6.3-2relates the study's results which were performed in the influenced area.

Table 6.3-2. Results for air quality PM10.

Date	Flow (m ³ /min)	Time (min)	Polluting mass (μg)	Concentration PM ₁₀ ($\mu\text{g}/\text{m}^3$)		
					+/-	
2015/11/24	1,0937	1466,4	2,3023E+04	15,21	+/-	1,08
2015/11/25	1,0195	1420,2	3,1667E+03	2,32	+/-	0,18
2015/11/26	1,0937	1422,0	6,8367E+03	4,66	+/-	0,34
2015/11/28	1,0937	1439,4	1,1860E+04	7,98	+/-	0,57
2015/11/29	1,1308	1255,2*	1,5620E+04		+/-	
2015/11/30	1,0937	1435,8	6,8667E+03	4,63	+/-	0,34
2015/12/01	1,0937	1428,6	5,6800E+03	3,85	+/-	0,28
2015/12/02	1,0937	1429,8	6,9767E+03	4,73	+/-	0,34
2015/12/03	1,0937	1433,4	1,6473E+04	11,13	+/-	0,79
2015/12/04	1,0937	1439,4	1,0213E+04	6,87	+/-	0,49
2015/12/05	1,0937	1438,8	7,1667E+03	4,82	+/-	0,35
2015/12/06	1,0195	1429,2	9,9533E+03	7,24	+/-	0,54
2015/12/07	1,0937	1433,4	6,8633E+03	4,64	+/-	0,34
2015/12/08	1,0937	424,2*	8,8533E+03		+/-	
2015/12/09	1,0937	1435,8	2,2113E+04	14,92	+/-	1,06
2015/12/10	1,0566	1431,6	1,1213E+04	7,85	+/-	0,57
2015/12/11	1,1679	1416,0	3,5250E+04	22,58	+/-	1,56

2015/12/12	0,0	0,0*			+/-	
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Source: INGEX, 2016.

In accordance with results above, it is determined that the impact is low since such values are within the allowable limit by the standard 610 in the year 2010. For this reason, there are no foreseeable impacts and/or effects of great importance in the influenced area where "El Pescado" mining project is expect to perform. In addition, it does not present nearby receivers or within the direct and indirect influence.

It is feasible that some wildlife species are affected by the emission of these particles, which are the most vulnerable in this area, but does not necessarily make it a significant ecological impact owing to these species tending to migrate to spaces with similar characteristics.

It is important to clarify that even though workers are exposed to pollution levels, the company will be responsible for providing them with the necessary elements of personal protection; complying with the regulations related to occupational health and safety. Although this impact is not a negative externality because the workers are a direct part of the project. This leads to not generating additional costs for the achievement of this goal and it will not be part of the economic valuation.

6.3.2.2.1.2 Change in the sound pressure levels

The increase of the sound pressure levels will be mainly caused by the blasting which are going to use during the mining, this action will principally harm the fauna species of the area; taking into account that on the location there is no presence of receptors. Additionally, within the modeling performed for this component, low levels of affectation are evident, oscillating between values of 50 - 55 dB, which deduced that the values are within the permissible ranges and of low environmental significance.

It is a fact that some species are more vulnerable than others, however this impact is not considered significant due to the mining activities in the area, the displacement of them will be generated in order to colonize areas where they can find the necessary and adequate resources for their proper development.

Finally, those impacts, which could be generated for the workers of the site, will be included within the budget of the project operation in the necessary endowment delivery and according to the specifications of the regulations related to occupational health and safety.

Therefore, this impact is not related to the economic valuation for the achievement of this goal, besides to taking into account that the mitigation measures proposed in the EMP must be established constantly.

6.3.2.2.1.3 Alteration of the physical-chemical and biological properties of the soil.

This alteration is chiefly due to possible direct effects on the ground, cause of: accidents of spills, circulation of heavy vehicles, blasting, open pit mines or an inadequate disposal of solid waste.

Confirms the studies presented in the EIA, this impact is not meaningful and is primarily caused with unexpected events in tailings and sterile deposit places, disposal of hazardous waste, among others; that will be mitigated at the time, through the implementation of the contingency plan and thus prevent the impact from spreading and generating a possible environmental emergency. Consequently, this impact is not contemplated within the economic valuation.

6.3.2.2.1.4 Geofom alteration

This environmental impact will be generated with greater importance during the construction phase due to the ground preparation activities (cutting and filling) that are related to the following project components: mine area, profit plant, internal access, road, dumps, solid waste, permanent buildings and temporary areas.

In accordance with the EIA of the project, the morphology of the area, where the project will be built and developed, are zones of low stubble intervened by economic activities such as livestock. However, the monitoring study mentions that such alteration is below the environmental quality standards established for soil quality. Thus, it is estimated that the alteration of the natural relief will be minimal and not very relevant in relation to the current conditions. Also, the landscapes that compromise the project area are of low singularity in the location, so the visual quality of the project area is low.

6.3.2.2.1.5 Ecosystem fragmentation

This environmental impact will occur during the construction phase due to the project activities such as: the generation of noise and vegetation removal which cause the displacement of fauna species existing in the zones. However, just as the EIA of the project, this environmental impact is the consequence of the impact related to the increase of noise levels already analyzed. Consequently, this environmental impact will not be valued economically.

6.3.2.2.1.6 Change in the available resource flow (water supply)

This environmental impact is considered within the activities of construction and assembly as well as the project operation, in which the water source will be more frequently used and alterations in the volume and velocity of the project currents could be presented. However, it should be clarified that in the hydrology study for the EIA, no damage to the water source is contemplated, not even spills of any material. Moreover, to guarantee the conservation of the ecological flows of the basins that are required for the ecosystem maintenance, the flora and fauna of the aquatic ecosystem as well.

Having in mind that the basin is not used by any type of user, it does not present water pressures, which leads to a possible use of 57% of the water supply; guaranteeing the ecological flows and sustaining demand from the area. Conclusively, the system does not present a degree of vulnerability of the water resource in the basins. In that way, changes in human and ecological well-being are not expected.

For that reason, this impact will not be considered within the economic valuation.

6.3.2.2.1.7 Alteration of the physical-chemical and microbiological quality of water

The possible water source impact will happen during the stage of construction and assembly and project operation, in which it will be collected for different uses like: domestic and industrial, even other impacts that can be generated by the washing machinery, accidental spills of some hazardous and solid waste.

According to what was presented in the EIA of the project, this impact is considered moderate, since various mitigation works will be used, those are explained in chapter 8 "PMA", and the proposed contingency measures. So that, if there is any type of accident, the necessary measures would be taken in the shortest possible time.

Likewise, such impact is generated by a negative externality and does not foresee changes in human and ecosystem well-being, thus, it has not been subject to economic valuation.

6.3.2.2.1.8 Loss of floristic diversity

This environmental impact will be generated with greater importance along the construction phase due to the land preparation activities, besides the two pits established in the mining concession 5969, which are related to the following project components: mine area, profit plant, storage, shipping and shipment, internal accesses, highway, electric transmission line, well for residual liquids, Effluent treatment plant, permanent buildings and temporary areas.

Bearing the flora study conducted in the EIA of the project, the morphology of the area where the "El Pescado" project will be built and developed are zones intervened by livestock, the mining and exploitation of wood resources, but not intervened such as the forests that are still preserve in the surroundings area. Nevertheless, the monitoring study mentions each strategies that will be carried out for the impacts mitigation and revegetation works. Besides to implementing the infrastructure in clean pastures coverage. Therefore, it is estimated that the alteration to individuals and composition will be minimal and not very relevant in relation to current conditions.

In any case, such environmental impact does not constitute a negative externality thereby there is no evidence that significantly affects human welfare. In conclusion, this impact will not be the subject of economic valuation.

6.3.2.2.1.9 Fauna displacement

The fauna displacement will be taken place in the construction and assembly stage, activity which will take advantage of plant cover and to chase away the wildlife; furthermore, the noise generated in the operation stage are activities that cause the displacement of the species of the fauna existing in the zones. However, according to the terrestrial fauna of the EIA of the project, this environmental impact is the consequence of the impact related to the increase in noise levels (mentioned above) and already analyzed. In like manner, in order to avoid double accounting, the analysis of this environmental impact will be made on forest fragmentation, which means that this environmental impact will not be valued economically.

6.3.2.2.1.10 Alterations in behavioral parameters in the fauna.

This environmental impact will be generated during all stages of the project due to the project activities such as: infrastructure construction, water capture and suspended sediments, which generates the ecosystem dynamics alteration.

However, in accordant studies carried out by the project, these activities in the zones, where the infrastructure is established, do not constitute a qualified habitat for the reproduction or survival of the species in the area. Moreover, these areas do not represent an opportunity cost for society, since they do not constitute a suitable area for fishing or intensive mariculture. Despite of above, the project has mitigation actions which are included in the environmental management plan in order to prevent this kind of impact.

In any case, that environmental impact does not constitute a negative externality because there is no evidence that significantly affects human welfare and irreversible alteration of the fauna component. Therefore, this environmental impact will not be subject to economic valuation.

6.3.2.2.1.11 Run over fauna

This alteration is mainly due to possible direct affectations to the fauna caused by run over in the roads of the project, speeds that exceed the recommendations, inappropriate use of the bridges for the fauna, inadequate maneuvers of the drivers and among others.

According to the studies presented in the EIA, this impact is not significant and is mainly due to unexpected events and/or accidents in the area, among others, which will be mitigated at the time, by implementing the Environmental Management Plans and avoiding that the impact spreads and generates a possible environmental emergency. Therefore, this impact is not contemplated within the economic valuation.

6.3.2.2.1.12 Change in migratory flows.

This impact will occur mostly in the construction, assembly and operation phase of the mining activities, it is because the displacement of the floating population as well as the one that is forced to leave the area due to insecurity or with the aim of increasing their quality of life; aspects which will generate changes in the population and its customs.

However, the occurrence of these events is not significant and therefore, this impact is not considered in the process of economic valuation, since it is considered an eventual impact.

6.3.2.2.1.13 Variation in the population distribution and location.

This social impact will only occur during the construction phase of the project due to the arrival of the foreign workers to the environment where the peasant communities live, which could bring together lifestyles and behavior patterns as the conflicts of those that already existing. However, the probability of occurrence is minimal of these eventual effects, so this environmental impact has not been considered in the process of economic valuation.

6.3.2.2.1.14 Alterations in population dynamics.

This social impact will arise during the construction and operation phase owing to project activities, which will require skilled and unskilled labor. This requirement will generate the attraction of the inhabitants of the nearby localities as well as of neighboring municipalities, which could increase the migration of people who look for employment and to arise new precarious human settlements and floating population. As well as, to other economic activities like the prostitution that affects the residents.

However, these eventual effects have a minimal probability of occurrence, so that this environmental impact has not been considered in the process of economic valuation. So, the possible impacts are not considered in any case and thus this impact will not be the subject of economic valuation.

6.3.2.2.1.15 Increase towards means of transport and infrastructure occupation demand.

The activities of the mining project "El Pescado" will increase public revenues in respect to the royalties' collection in favor of the municipality of Segovia. In this sense, the project constitutes an opportunity to generate greater wealth that can be used for investments of improving and developing the productive infrastructure and basic services of the population, due to tax collection for minerals exploitation, such as gold.

On the other hand, the payment of mining royalties is not constituted as an externality since it is part of the contract between the mining company and the government. Therefore, this impact will not be subject to economic valuation as it has shown, such payment is already included as part of the investment through the project.

6.3.2.2.1.16 Modification in landscape structure

This environmental impact will be generated essentially during the construction phase due to the cutting and filling activities and the generation of the two pits of the project, which cause the change of topography and landforms. However, this environmental impact was already analyzed in the impacts referring to the changes in the land use. Consequently, in order to avoid double counting, this impact will not be subject to economic valuation.

6.3.2.2.1.17 Alteration of the archaeological heritage.

This cultural impact will be generated only during the construction phase because of the project activities that involve the removal of soil, excavation, etc. However, in accordance to the baseline of the same, the archaeological survey was carried out and archaeological remains were not found.

Considering the EIA of the project, this impact will be of low significance since no vestiges were found, besides the fact that the company has preventive measures in order to prevent such impact may occur through the certification of archaeological remains inexistence (ICANH). This certification is a protocol that the company has on before the start of its activities, in which the company commits itself that in case archaeological remains are found, for actions stop and the Colombian Institute of Anthropology and History (ICANH) can take actions.

In addition, the company has mitigation measures included in the Environmental Management Plan of the EIA. For the foregoing, this impact will not be subject of economic valuation.

6.3.2.3 Impacts that are subject to economic valuation

6.3.2.3.1.1 Changes in the land use.

The change in land use will be generated principally during the construction and also assembly operation stages, it is because the project activities such as: mixture of horizons by the removal in the movement of earths and the compaction of the superficial horizons by the transit of machinery and vehicles.

The areas to be intervened with represent an opportunity cost for the nearby populated centers and especially for the owners of the land, according to the EIA of the project, that areas are suitable for agriculture due to the topographic characteristics of the soil. In the study area, the crops are not common, the inhabitants use the land to make livestock and in the valuation analysis it will be performed for the common economic activity of the area.

The method that is proposed to use the market price method, which consists of estimating the associated costs with the amount of cattle and the income obtained by them in a period of time equivalent to 3 stages of the project (Table 6.3 3)

To make the projections of cattle weight gain, the following variables were taken into account: Area to be subtracted (Hectare) 14.3, Bovine (Quantity / Hectare) = 4 *, Total Cattle in the area to be subtracted 57.2, Bovine sale value (\$ / Kg) 3,800 **, Weight projected by Cattle 1 year (Kg) = 180 2,5 years (Kg) = 480*** (Table 6.3-4)

Table 6.3-3. Production projection of cattle in influenced areas.

Phase	Period	years	Amount of Bovines to sell	Bovine weight to sell	sales revenue
Construction	1	2,5	57,2	27456	104.332.800
Production	2	5	57,2	27456	107.462.784
	3	7,5	57,2	27456	110.686.668
	4	10	57,2	27456	114.007.268
	5	12,5	57,2	27456	117.427.486
Close and Abandon	6	15	57,2	27456	120.950.310
	7	17,5	57,2	27456	124.578.819
	TOTAL	17,5	400,4	192192	799.446.134

* <http://www.contextoganadero.com/> - 10-08-2016

** <http://www.contextoganadero.com/> - 10-08-2016

*** http://www.contextoganadero.com – 10-08-2016

Source: Ingex, 2016.

Table 6.3-4. Approximate incomes projected in influenced areas.

Phase	Approximate income from selling cattle (\$)
(\$) Construction	31.299.840
Production	522.617.165
Close and abandon	245.529.130

6.3.2.3.1.2 Generation of employment

This impact will be arising during the construction and operation stages due to the activities related to the project, which will have the labor force requirement. However, it is estimated that said requirement of unskilled labor would be limited and equitable in the localities of the area of direct social influence (AISD) of the project.

This impact would generate a highly positive effect at local level, since the unskilled labor that the company would demand for the performing of the project, is evidenced by an increase in job

opportunities for the population located in the area where the project will influence. Which a leads to a higher level of income and a boost to the economy of the region. For its valuation, the market price method is used, and in particular the value of the labor contracted and hired by the project in its three stages.

Considering the information presented in Table 6.3-5, a non-qualified labor contract value of \$ 257 million is estimated during the construction and assembly phase, \$ 7,362 million in the operation and \$ 1,073 million in the closing and skilled labor, that corresponding to \$ 364 million during the construction and assembly phase, \$ 16,018 million in the operation and \$ 834 million in the closing.

Table 6.3-5. Direct employment generated by stage

ITEM	Construction and assembling		Production		Close y abandon	
	No qualify	qualify	No qualify	qualify	No qualify	qualify
Type of employment by stage (Direct) *	83	27	72	24	7	3
Total jobs per stage (Direct) *	110		96		10	
Projected cost of labor (Direct)	\$257.511.069	\$364.500.000	\$7.362.706.844	\$16.018.560.000	\$1.073.728.081	\$834.300.000

* The qualification proportions of the personnel to be hired are estimated at 25% qualified and 75% semi-unqualified

Source: Ingex, 2016.

The cost-benefit analysis will consider the time in each stage of the project, with an inflation rate corresponding to each hiring period, as well as the discount rate proposed by the DNP for Colombia in 2015, to make the distribution of the labor value.

6.3.2.3.1.3 Increase in economic strengthening

The modification in economic strengthening of the region will be directly expressed in the economic strengthening of the municipality, it is presented as a positive impact in the operation stage of the project owing to the additional municipal revenues generated from royalties and a high negative impact for unearned income in the closing and abandonment stage.

For its valuation, the market price method is used and in particular the value of the royalties to be generated during the operation of the mining project. As established in Paragraph 9 of Article 16 of Law 756 from 2002, the value of gram gold, silver and platinum in the mouth of the mine to liquidate royalties will be 80% of the average international price of the last month. Based on the price estimates made by Touchstone Colombia, the value of the royalties to be paid is presented below and will result in an increase towards municipal finances. (Table 6.3-6).

Table 6.3-6. Estimated payment of royalties in the useful project life.

Year	Payment royalties Gold (\$)	Payment royalties Silver (\$)	Total of royalties (\$/year)
1	159.461.478	790.053	160.251.531
2	214.116.976	1.060.844	215.177.820
3	214.116.976	1.060.844	215.177.820
4	214.116.976	1.060.844	215.177.820
5	214.116.976	1.060.844	215.177.820
6	214.116.976	1.060.844	215.177.820
7	214.116.976	1.060.844	215.177.820
8	214.116.976	1.060.844	215.177.820
9	104.736.603	518.918	105.255.521
10	209.473.206	1.037.837	210.511.043
11	209.473.206	1.037.837	210.511.043
Total	2.181.963.325	10.810.556	2.192.773.881

6.3.2.4 Cost Environmental Benefit Analysis –CEBA

Once the economic evaluation of project impacts has been prepared, an environmental cost-benefit analysis will be carried out, which corresponds to the balance of benefits and costs generated by the project to society; with a view to determining the consequences for it, through an ex ante evaluation of the implementation of the project. For that, the economic values of the monetized impacts are recognized as social environmental costs and as social benefits. The value of prevention measures, correction, mitigation and compensation in the estimated costs for temporary closure (PMA), as well as the royalties generated by the operation and the positive impacts of the project. Said costs and benefits are transferred to the project flow as inputs in the Cost Environmental Benefit Analysis – CEBA.

It should be noted that the temporality of the impacts was adjusted to the useful life of the project, in this sense, the valuated impacts are projected up to the closing stage, with the exception of the increase in sound pressure levels and the alteration of air quality, which have their effect in the operation stages: construction and operation respectively (Table 6.3-7 and Illustration 6.3-1).

Table 6.3-7. Environmental costs and benefit analysis represented to VPN.

Environmental Benefit Cost Analysis	Unit of measurement	Unit value	Total value (Lifetime)	VPN
Environmental / social benefits				
Increase in economic strengthening	\$/year	128.986.699	2.192.773.881	905.686.983
Generation of Employment	\$/year	1.524.194.470	25.911.305.994	10.702.212.729
Total environmental benefits		1.653.181.169	28.104.079.875	11.607.899.712
VPN environmental benefits			11.607.899.712	
Environmental / social cost				
Change in land use		47.026.243	799.446.134	330.197.273
Total environmental benefits		47.026.243	799.446.134	330.197.273
VPN environmental benefits			330.197.273	
Environmental cash flow				11.277.702.438

As is indicated in the technical manual for the economic evaluation of environmental impacts in projects subject to environmental licensing by the Ministry of Environment, Housing and Territorial Development (MAVDT) and the Center for Economic Development Studies (CEDE) of the Los Andes University (2010); Once the CEBA is done, the VPN test and the benefit / cost ration (RBC) should be calculated and analyzed. In this sense, the NPV of the environmental cash flow is positive and corresponds to \$ 11,277,702,438 which indicates that the benefits of the project are greater than the costs, therefore, the project is accepted and it is predicted that this will generate welfare gains Social. Calculated IRR corresponds to an infinite value. On the other hand, the RBC gives a result higher than 1; which allows to suppose that the project will generate social welfare, therefore its

implementation is accepted. It is worth noting that, since most of the project flows are positive, because the benefits are greater than the costs, the calculated IRR corresponds to an infinite value.

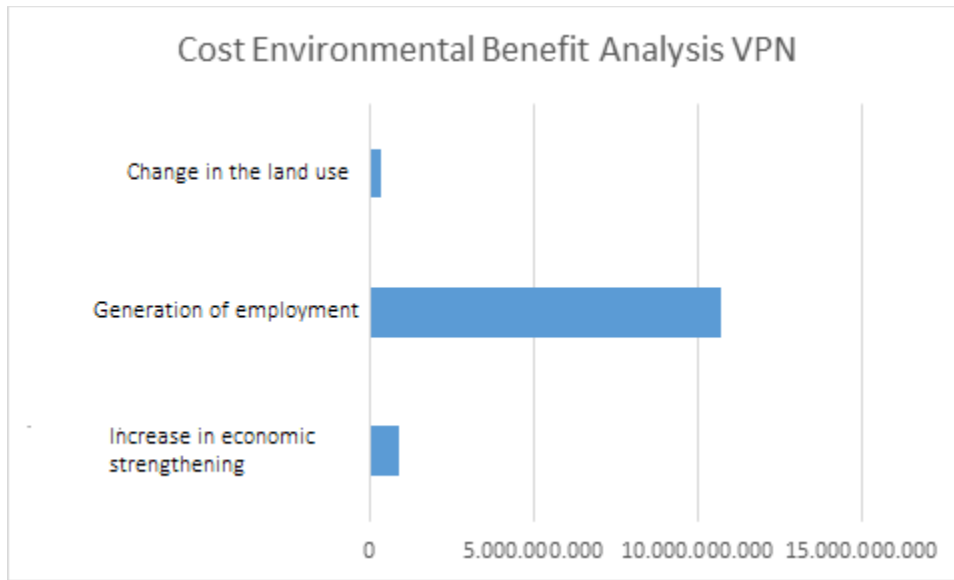


Illustration 6.3-1. Cost analysis /Environmental benefit VPN.

Finally, the results show a positive net balance that indicates that the management measures not only manage to correct, prevent, mitigate or compensate the impacts, but leave significant positive residual effects for society; improving social welfare, as well as efficiency in terms of ecosystems and natural capital intervened.

The sensitivity analysis allows to identify how sensitive the project indicators are (VPN and RBC) to variables such as: royalties, discount rate and project life time. In this case, the sensitivity is calculated with the modification of the discount rate and the royalty level of the project. The useful life of the project is not modified, because this parameter has a technical support derived from the material reserves which are evidenced in the exploration phase.

If the royalty level is reduced as a result of a decrease in the level of production, the impact on the project indicators would be much more relevant than if the discount rate established for the country were modified. In this sense, a 10% reduction in the royalties' volume produces a decrease in the cost-benefit ratio and going from 1:35 to 1:32, as well as a reduction in the VPN of 11% going from \$ 815,118,284 to \$ 905,686,983.

Table 6.3-8. Consolidated of Non-internalizable Impacts identified.

Phase	Impact level	
	(-)	(+)
Construction and assembling	17	5

Phase	Impact level	
	(-)	(+)
Production	16	6
Close and abandon	6	10

A total of 22 environmental impacts have been evaluated and prioritized over the life of the project, of which 17 are negative and 5 are positive in the construction and assembly phase, in the production stage 16 are negative and 6 positive and in the closing and abandonment stage 6 negative and 10 positive (Table 6.3-9).

Table 6.3-9. Consolidated Non-internalizable Impacts Identified according to the level.

Impact level	Construction and assembling		Production		Close and abandon	
	(-)	(+)	(-)	(+)	(-)	(+)
Low	4	0	3	0	1	2
Moderate	7	0	7	1	0	8
High	6	5	6	5	6	
NA*	0		0		5	
Total	17	5	16	6	7	10

N.A*: Not Applicable or Not Significance

Source: Ingex, 2016.

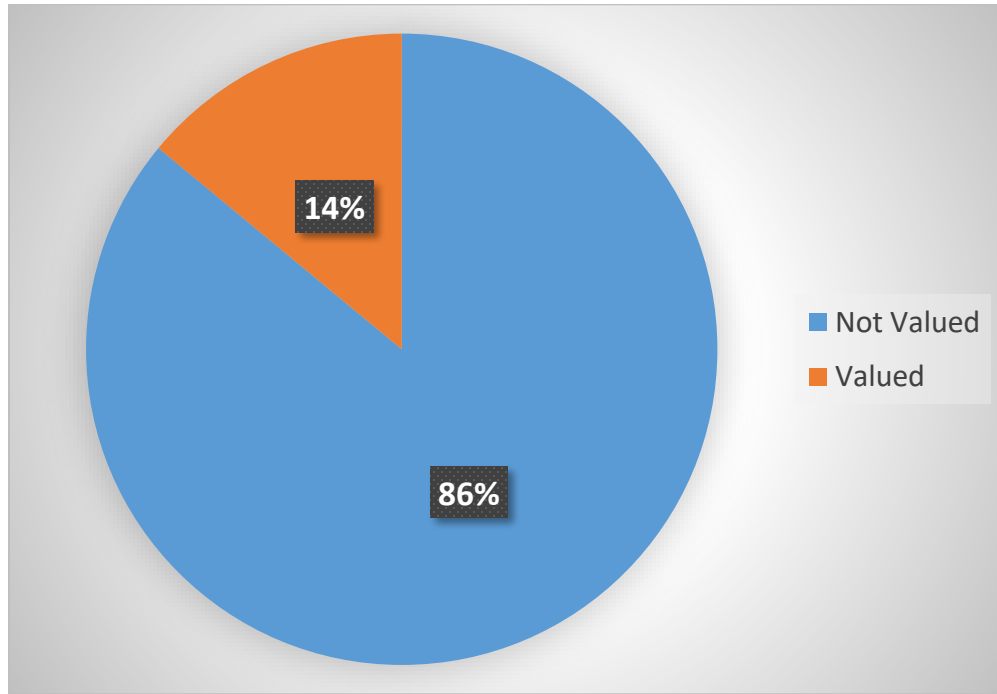


Illustration 6.3-2. Impacts that affect population welfare

Once each of the impacts identified were analyzed regarding to negative and positive significance, the data evidences that only 14% of them would be subject to economic valuation owing to their relationship with the population welfare that were acknowledged in the Environmental Impact Study. After a deep examination of different data collected through some research, the 86% of the environmental impacts do not influence population wellbeing, due to certain cases that do not exceed the permitted standards or the management plan that minimizes the effects of the impact.