ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT PUERTO BOLÍVAR – PHASE 1 –

- IMPACT ASSESTMENT -

Prepared for:

YILPORT TERMINAL OPERATIONS, YILPORTECU S.A.

Prepared by:

ECOSAMBITO C.LTDA.

December 2020

Table of Content

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT PUERTO BOLÍVAR – PHASE 1 –

- ENVIRONMENTAL AND SOCIAL IMPACT IDENTIFICATION AND ANALYSIS –

Prepared for:

YILPORT TERMINAL OPERATIONS, YILPORTECU S.A.

Prepared by:

ECOSAMBITO C.LTDA.

December 2020

Table of Content

List of Tables

List of Matrix

EXECUTIVE SUMMARY

Once the Project's operating activities have been established and its areas of direct and indirect influence and their characteristics, it is then possible to conduct identification and assessment of environmental impacts, either positive or negative, through a semi-quantitative methodology.

Impacts have been identified for operating, construction, and dredging activities in the physical, biotic and social environment. The analysis results show that environmental and social impacts fall, for the most part, into moderate the negative and mild negative categories, although there are also severe negative impacts associated with greenhouse gas emissions, in addition to positive impacts related to employment and economic invigoration generated by the port activity.

In addition, a residual impact assessment has been carried out to determine the result of the environmental and social impact rating once the corrective measures have been implemented. This exercise shows that some environmental impacts significantly decrease in value, and others are nullified, as is the case of those related to waste management.

Regarding the emission of greenhouse gases, which is the impact that maintains the highest values, it is recommended to include actions aimed at changing energy sources in the operations in which YIKPORTECU S.A. has an impact, considering including machinery and vehicles powered by electric energy, or the provision of facilities that use alternative energy sources such as solar or wind power.

IDENTIFICATION AND ANALYSIS OF ENVIRONMENTAL AND SOCIAL IMPACTS AND RISKS.

The Environmental Impact Assessment (EIA) allows predicting the environmental and social impacts and risks of a project. To do so, it is necessary to know both the Environmental Baseline and the details of the activities and elements of the project that could cause a measurable change in the environmental components.

In order to identify the environmental impacts caused by the operating activities of Puerto Bolívar Port Terminal on the environmental components, an analysis must be conducted of the environmental characteristics of the studied area; the activities carried out in the Project, the inputs used, the waste produced, their storage and final disposal, and occupational, environmental and social risk factors, which are elements that determine the Project's potential environmental and social impacts on their environment.

The environmental impact assessment is conducted according to a methodology in which the Environmental aspects and Impacts interact. The environmental aspects are elements or components in activities that interact with the environment. Environmental impacts are either positive or negative, that occur in the environment due to the aspect, i.e. the effect produced by a specific human practice on the environment in its different components. The identification of the most significant impacts serves the purpose of establishing procedures to be included within the Environmental Management Plan for controlling and tracking those impacts.

1. IDENTIFICATION AND DESCRIPTION OF ENVIRONMENTAL AND SOCIAL IMPACTS.

This section presents an overview of potential effects on the different environmental components: physical, biotic, and social; it identifies environmental aspects and impacts alike associated with the different project stages: operation, construction, and dredging. Results are shown in Table 1.

Table 1. Identification and description of environmental aspects and impacts by activity

OPERATION				
Environ.	**Component**	**Environmental Aspect**	**Environmental impact**	**Description**
Physical	Water	General waste production	Inappropriate disposal of general waste that reaches the sea	General, organic or inorganic, recyclable, or non-recyclable waste may be disposed of incorrectly by own or third-party employees and reach the sea, thereby affecting water quality and marine fauna
		Water quality in effluents or accidental discharges	Risk of hazardous substances and hydrocarbon spills into water	The use and storage of hydrocarbons, chemical substances, or other solid or liquid substances that disregard the technical regulation on storage and technical handling could cause spills and discharges that affect water quality.
	Air	Traffic and operation of port machinery	Gas emissions from mobile sources (land and maritime)	Machinery operation, vehicle entry and exit, and vessel emissions will alter the air quality in the project area of influence.
		Traffic and operation of port machinery	Greenhouse gas emissions	The use of fossil fuels in different port operations, particularly in transport operations, will produce greenhouse gases that cause global warming.
		Traffic and operation of port machinery	Particulate matter emissions due to vehicle and machinery operation	Hydrocarbon combustion in internal combustion engines is the main source of particulate matter that alters ambient air quality and can cause health problems when concentrations rise above the recommended limits.
		Traffic and operation of port machinery	Increase in noise and vibration levels due to vehicle and machinery operation	Machinery operation and goods transportation procedures to and from the port increase sound pressure and vibrations, which affects workers inside the port as well as the community that lives and carries out their activities around the port terminal access points.
	Soil	General waste production	Potential inappropriate disposal of general waste	General waste (non-hazardous) could be disposed of incorrectly by own or third-party employees and alter soil quality.
		Storage and use of hazardous materials	Potential inappropriate disposal of	Storage and final disposal of non-hazardous waste must be performed in strict compliance with the

OPERATION				
Environ.	**Component**	**Environmental Aspect**	**Environmental impact**	**Description**
			hazardous waste	environmental legislation and the technical regulation. Inappropriate handling thereof could cause soil pollution with long-term consequences.
		Storage and use of hazardous materials	Risk of hazardous substances and hydrocarbon spills into soil	Storage and use of materials with corrosive, reactive, explosive, toxic, flammable, and biological-infectious characteristics must be performed in strict compliance with the environmental legislation and technical regulation. Inappropriate handling thereof could cause spills and discharges that alter soil quality permanently.
		Storage and use of hazardous materials	Risk of hazardous substances and/or contaminants percolation into the subsoil	Inappropriate hydrocarbon storage conditions, such as non-watertight tanks, permeable soils, and lack of spill containment basins could cause contamination plumes that percolate through the subsoil and reach bodies of underground water causing permanent alterations in the quality of these components, which are particularly difficult to remedy.
Biotic	Marine fauna	Port traffic	Effects on marine fauna due to collisions with vessels	Vessel traffic may cause occasional collisions with marine mammals or sea turtles.
	Marine coastal flora and fauna	Storage and use of hazardous materials	Effects on marine flora and fauna due to hazardous substances spills	Potential spills of hydrocarbon or other hazardous substances from the port terminal or vessels arriving at sea could cause effects on marine coastal flora and fauna.
	Marine coastal avifauna	Port traffic	Effects on marine avifauna due to gas, noise, and vibration emissions	The operation of large vessels and their gas, noise, and vibration emissions could cause effects on coastal marine avifauna, even though coastal birds that nest in the areas closest to the Project.

	Ecosystem services	Port operation	Variation in food supply (fishery products)	The port operation does not invade fishing areas in bodies of water, nor does it invade pedestrian areas. During the time the port terminal has operated, the fisheries have adapted to the vessel traffic in the area. On the other hand, there is no other type of food production or supply on land that is affected by the port operation.
		Port operation	Variation in ecosystem regulating services: carbon sequestration and water purification provided by mangroves.	The mangrove is very valuable for the regulation services it provides. The port operation will not affect the mangroves, so these ecosystem services will not be affected either.
		Port operation	Variation in cultural services: landscape and recreation.	The port terminal has been part of the landscape in the area of influence for 50 years. No cultural services are expected to be affected by its current or future operation.
		Port operation	Impact on soil formation and primary production.	The mangrove forest will not be affected by the port operation, so neither will the support services it provides to natural processes such as soil formation and primary production.
Social	Occupational	Workforce	Risk of occupational accidents	Occupational accidents are a latent risk in any productive activity. Some risk factors include machinery operation

OPERATION				
Environ.	**Component**	**Environmental Aspect**	**Environmental impact**	**Description**
				and transit, suspended loads, high-rise work, etc.
		Workforce	Job creation	Port operation is an important source of direct and indirect employment.
	Community health and safety	Port activities.	Effects on community health	Different types of community health problems can be caused by project activities, which have been identified in the Community Health and Safety Assessment, and they include: Creation of breeding grounds for vectors. Road traffic, rise in pedestrian activity Unplanned discharges/emissions Adjacent populations with unplanned discharges Hazardous material displacement by truck. Release of contaminants into bodies of water used by the community
		Infrastructure and equipment design and safety	Risks on population safety and health due to faulty infrastructure	It includes all risks an outside person is exposed to upon entering the infrastructure: physical trauma due to building collapse, burns and smoke inhalation in case of fire, injuries as a result of falls or contact with heavy machinery, alterations in the respiratory system caused by noxious dust, fumes or odors, exposure to hazardous materials
		Emergencies and fires	Effects on the community in the event of emergencies and fires	Based on their scale, some incidents or accidents can affect to different degrees the community associated with the Project. Said emergencies may include: explosions, fires, accidental leaks or discharges, etc.
		Safety personnel	Risks of violation of human rights.	Contracting the services of security personnel entails the risk of excessive use of force and violation of the population's human rights.

OPERATION				
Environ.	**Component**	**Environmental Aspect**	**Environmental impact**	**Description**
	Community relations	Interaction with social actors	Risk of conflicts with social actors	Port terminal operation raises expectations from the community, which must be proactively oriented by the project management.
	Socio-economic	Commerce and services	Invigoration of the local economy	Banana and shrimp—the province's main productive activity—are exported via this terminal, which directly benefits the local economy,
		Tourism	Tourism incentive in Puerto Bolívar and nearby recreational areas.	Puerto Bolívar modernization and the arrival of larger vessels can stimulate tourism in Puerto Bolívar and adjacent recreational areas, both on the coast and the archipelago.

CONSTRUCTION				
Environ.	**Component**	**Environmental Aspect**	**Environmental impact**	**Description**
Physical	Water	Sewage water production	Potential temporary alteration of water quality due to inappropriate disposal of sewage water	The activity of several people during pier 6 construction will require adequate sanitary facilities in order to prevent feces from contaminating the water.
		General waste production	Inappropriate disposal of general waste that reaches the sea	From input packaging to food tubs, waste of different sources can reach the sea, even in large amounts, if the necessary steps are not taken to manage general waste properly.
		Storage and use of hazardous materials	Potential hazardous substance spills in offshore works	Storage of hydrocarbons or other chemical substances that disregard the technical regulation on storage and technical handling of these substances may cause spills and discharges that affect water and soil quality.
	Air	Traffic and operation of	Alteration in air quality due to	Construction materials supply and waste evacuation will temporarily

CONSTRUCTION				
Environ.	**Component**	**Environmental Aspect**	**Environmental impact**	**Description**
		heavy machinery	traffic associated with the supply of construction materials	increase flue gas emissions from different means of transportation.
		Traffic and operation of heavy machinery	Greenhouse gas emissions	Construction materials supply and waste evacuation will temporarily increase greenhouse gas emissions from different means of transport.
		Traffic and operation of heavy machinery, earth-moving	Particulate matter emissions due to earth and aggregate moving operations	Excavations, earth-moving, backfills, and materials transport can temporarily increase particulate matter and dust levels in the environment.
		Traffic and operation of heavy machinery	Noise and vibrations due to heavy machinery operation	Noise and vibration levels will temporarily increase as a result of construction activities. This impact will be limited to the working areas.
	Soil	Storage and use of hazardous materials	Potential hazardous substance and hydrocarbon spills	Storage of hydrocarbons or other chemical substances that disregard the technical regulation on storage and technical handling of these substances may cause spills and discharges that affect water and soil quality.
Biotic	Mangrove flora	Variations in current patterns and sediments	Potential effects on dwarf red mangrove remains or loss thereof	The new pier construction may affect an area of 0.6 ha of mangrove that has developed in the rockfill structures of the coastal area behind the new pier.
	Benthic fauna	Seabed dredging	Alteration in benthic fauna due to offshore dredging and works	Dredging in the intervention areas during pier 6 construction will temporarily affect the fauna developing in this seabed. This impact is specific and temporary.
	Marine mammals	Underwater noise	Effects on marine fauna due to underwater noise as a result of pile driving	Pile driving will cause an increase in ambient and underwater noise. Although underwater noise propagates over long distances, fish can quickly migrate to less affected areas. Marine mammals are affected the most since noise can alter their communication and localization capabilities. This impact will

CONSTRUCTION				
Environ.	**Component**	**Environmental Aspect**	**Environmental impact**	**Description**
				be limited to the duration of pile driving activities.
	Ecosystem services	Construction	Ecosystem servicesVariation in food supply (fishery products)	The port operation does not invade fishing areas in bodies of water, nor does it invade pedestrian areas. During the time the port terminal has operated, the fisheries have adapted to the vessel traffic in the area. On the other hand, there is no other type of food production or supply on land that is affected by the port operation.
Infrastructure and equipment design and safety	Risks on population safetyand health due to faulty infrastructure	Heavy machinery operation	Risk of occupational accidents	Occupational accidents are a latent risk in any productive activity. Some risk factors include machinery operation and transit, suspended loads, high-rise works, etc.
		Workforce	Job creation	Pier 6 construction will create significant workforce demand, although this positive impact will be temporary.
		Temporary workforce	Lack of job opportunities upon project completion given the temporary nature of the work	As a result of the high labor demand during the construction, medium and long-term employment expectations could be raised concerning Puerto Bolívar project. Therefore, a termination of employment plan for this workforce should be in place.
	Community health and safety	Port activities.	Effects on community health	Different types of community health problems can be caused by project activities, which have been identified in the Community Health and Safety Assessment, and they include: Creation of breeding grounds for vectors. Road traffic, rise in pedestrian activity Unplanned discharges/emissions Adjacent populations with unplanned discharges Hazardous material displacement by truck. Release of contaminants into bodies of water used by the community

				Includes all risks an outside person is exposed to upon entering the infrastructure: physical trauma due to building collapse, burns and smoke inhalation in case of fire, injuries as a result of falls or contact with heavy machinery, alterations in the respiratory system caused by noxious dust, fumes

CONSTRUCTION				
Environ.	**Component**	**Environmental Aspect**	**Environmental impact**	**Description**
				or odors, exposure to hazardous materials
		Emergencies and fires	Effects on the community in the event of emergencies and fires	Based on their scale, some incidents or accidents can affect to different degrees the community associated with the Project. Said emergencies may include: explosions, fires, accidental leaks or discharges, etc.
	Community health and safety	Port activities.	Effects on community health	Different types of community health problems can be caused by project activities, which have been identified in the Community Health and Safety Assessment, and they include: Creation of breeding grounds for vectors. Road traffic, rise in pedestrian activity Unplanned discharges/emissions Adjacent populations with unplanned discharges Hazardous material displacement by truck. Release of contaminants into bodies of water used by the community
	Heritage	Excavations	Potential effect on archaeological goods in construction activities	Construction activities may lead to the unexpected discovery of pieces of archaeological value.

DREDGING				
Environ.	**Component**	**Environmental Aspect**	**Environmental impact**	**Description**
Physical	Water	Dredged material disposal at the seabed	Temporary alteration of water quality at the dredged sediment disposal site	Sediments extracted from the dredging areas are disposed of in an offshore sediment basin. When dredged sediments are discharged, water quality is affected, particularly its turbidity. This impact is temporary, whereas suspended solids settle.
	Air	Dredge operation	Alteration in air quality due to gas emissions from the dredge	The dredge performs intensive work during its operational days; therefore there will be an increase in emissionsto the air. This impact is temporary and does not significantly affect emissions produced during the port terminal operation.
		Dredge operation	Greenhouse gas emissions	The dredge performs intensive work during its operational days; therefore there will be an increase in greenhouse gas emissions. However,this impact is temporary.
		Noise and vibration	Noise increase	The dredge will produce noise and vibrations during its operation. The effect will be slightly stronger than on normal terminal operating conditions.
	Soil	Dredged material disposal at the seabed	Temporary alteration in soil quality (seabed) at the dredging disposal site	Sediments extracted from the dredging areas are disposed of at an offshore sediment basin. When the material settles at the seabed, it altersits physicochemical composition by transferring contaminants from the dredged site seabed.
Biotic	Marine fauna	Dredged material disposal at seabed	Temporary impact on marine fauna at the dredging disposal site	Temporary water turbidity due to sediment disposal temporarily affects marine fauna, mainly fish, which will temporarily migrate to higher water quality areas.
	Benthic fauna	Seabed material extraction	Temporary impact on benthic marine fauna at the dredged areas	Sediment extraction at dredged areas and incorporating these sediments in the disposal site will temporarily alter benthic fauna. Nevertheless, said fauna recovers quickly once the activity that produces the effect ceases.

	Ecosystem services	Extraction of materials from the seabed	Variation in food supply (fishery products)	During dredging operations, the fish near the dredging and bucket area will be moved to more distant areas. However, monitoring has shown that shrimp and fish are abundant in the areas close to the dredged areas.
Social	Occupational	Dredge operation	Risk of occupational accidents	As with any operation involving the use of machinery, there will be a risk of occupational accidents that must be prevented and managed.
		Labor force	Employment generation	The dredging activity will generate employment on a one-time and temporary basis.

Prepared by: Ecosambito, 2020

2. ENVIRONMENTAL IMPACT ASSESSMENT

This assessment will take into account both potential environmental impacts (predictive in nature) and residual impacts (impacts remaining after the expected corrective measures have been implemented).

2.1. Methodology

The environmental impact assessment will be conducted using the Modified Leopold Matrix method. This matrix shows the potential environmental impacts identified for the physical, biotic and human components and determines impact significance. The classification process for environmental impacts considers all project stages, especially those associated with construction activities and their effects on the natural environment as well as on those related to socio-economic aspects within the area of influence.

A series of standard assessment criteria has been prepared so as to evaluate the importance of these effects on the environment, which are presented below:

- Direction (positive or negative)
- Geographical expanse
- Duration
- Magnitude
- Probability of occurrence
- Frequency
- Reversibility

The classification method uses the previously defined environmental assessment criteria, and consists in assigning semi-quantitative parameters established on a relative scale, such that every project activity correlates with the corresponding environmental impact produced. This assessment creates an index reflecting the quantitative and qualitative characteristics of the impact.

On the basis of assigning values within the corresponding ranges, a matrix is generated that

determines the significance and hierarchy of the different impacts. Then, by means of a formula that includes all the attributes, a numerical value is obtained that allows for drawing comparisons.

The Environmental Classification for each impact (CA) results from the interaction of each attribute to determine the characteristics of the environmental impacts. The classification is shown in the following equation: CA= D x Po x (M + E+ Du + F + R).

Table 2. *Evaluation criteria and value ranges.*

Symbol	Attribute	Value range
D	Direction	-1 to +1
M	Magnitude	0 to 3
Du	Duration	1 to 3
R	Reversibility	0 to 3
E	Geographical expanse	1 to 3
F	Frequency	0 to 4
Po	Probability of occurrence	0.1 to 1

2.1.1. Environmental Assessment Criteria

The criteria application depends on the environmental assessment being conducted and the environmental sensitivities of the components identified in field and reference studies.

Table 3. *Semi-qualitative analysis of the Environmental Assessment criteria*

DIRECTION (D)		
Negative	-1	Net damage to the resource
Positive	1	Net benefit to the resource
Neutral	0	No benefit or harm to the resource
PROBABILITY OF OCCURRENCE (Po)		
High	1	When the appearance of the effect is known with certainty
Medium	0.9-0.5	Likely, the probability of occurrence is probable
Low	0.4-0.1	Low probability of occurrence
MAGNITUDE (M)		
High	3	Predictable effects exceed the limits associated with potential adverse effects, or cause a detectable change in environmental aspect, beyond the natural variability or social tolerance
Medium	2	The effects are considerably above typical existing conditions, but do not exceed the criteria defined in the allowable limits or cause changes in the economic, social or biological parameters below the ranges of natural variability or social tolerance
Low	1	It is estimated that the disturbance will be slightly higher than the typical existing conditions
None	0	No change is expected
GEOGRAPHICAL EXPANSE (E)		
Regional	3	It extends beyond all sub-regional or administrative limits specified for each indicator, but confined to the region
Sub-regional	2	Extends beyond the directly disturbed areas but is within the limits of the assessed area (generally 1 km or less from the disturbed areas)
Local	1	Confined to the area directly disturbed by the Project.
DURATION (Du)		
Long	3	More than a year
Medium	2	Between 6 and 12 months
Short	1	Less than 6 months
FREQUENCY (F)		
Continuous	3	Will occur constantly
Isolated	2	Confined to a specific period
Occasional	1	Occurs intermittently but repeatedly
Accidental	0	Rarely occurs
REVERSIBILITY (R)		
Irreversible	3	Permanent effects
Reversible in the long term	2	Can be reversed in more than 1 year
Reversible in the medium term	1	Can be reversed in between 6 and 12 months
Reversible in the short term	0	Can be reversed in 6 months or less

2.1.2. Impacts hierarchy

Environmental impacts classified for all the environmental components are assessed according to the significance criteria using the following value ranges:

Table 4. *Significance value ranges*

RANGE	GRADE	COLOR CODE
0 to 15	Positive	Blue
-5 to 0	Mild negative	Yellow
-10 to -5.1	Moderate negative	Orange
-15 to -10.1	Severe negative	Red

Once the impacts have been assigned a value in accordance with these ranges, a “summary matrix” is prepared with the obtained results

3. ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT

The following are the evaluation matrices of potential and residual environmental and social impacts, using the methodology described above. In order to reduce subjectivity in assigning values to each of the qualification criteria, these have been discussed by the multidisciplinary team that participated in the preparation of the Environmental and Social Impact Study.

3.1. Evaluation of potential impacts.

Matrix 1. Assessment of potential environmental and social impacts

	MEDIO	COMPO-NENTE	IMPACT	Address	Probability	Magnitude	Extension	Duration	Frequency	Reversibility	QUALIFICATION	HIERARCHIZATION
OPERATION	Physicist	Water	Poor disposal of common wastes that end up in the sea	-1	0,05	1	1		1		-0,4	Slight negative
			Alteration of water quality due to effluents or accidental spills	-1	0,4						-5,2	Moderate negative
		Air	Gaseous emissions from mobile sources (land and marine)	-1	1		1	1		1	-8	Moderate negative
			Greenhouse gas emissions	-1	1						-15	High negative
			Particulate matter emissions from vehicle and machinery operation	-1	1	1		1		0	-7	Moderate negative
			Increase in noise and vibration levels due to operation of vehicles and machinery	-1	1		1	1		0	-7	Moderate negative
		Soil	Possible poor disposal of common waste	-1	0,1	1	1	1		1	-0,6	Slight negative
			Possible improper disposal of hazardous waste	-1	0,1						-1,2	Slight negative
			Risks of spills of hazardous substances and hydrocarbons on the ground.	-1	0,25						-3	Slight negative
			Risk of infiltration of hazardous substances and/or contaminants into the subsoil.	-1	0,1						-1,2	Slight negative
	Biotic	Marine fauna	Impact on marine fauna due to collision with vessels	-1	0,1	1		1	1		-0,8	Slight negative

	MEDIO	COMPO-NENTE	IMPACT	Address	Probability	Magnitude	Extension	Duration	Frequency	Reversibility	QUALIFICATION	HIERARCHIZATION
		Coastal marine flora and fauna	Impact on marine flora and fauna due to hazardous substance spills	-1	0,3	1					-3,3	Slight negative
		Coastal marine avifauna	Impact on marine avifauna due to gas emissions, noise and vibrations.	-1	0,3	1				1	-3	Slight negative
		Ecosystem services	Variation in food supply (fishery products)	0	0	0	0	0	0	0	0	No impact
			Variation in regulating ecosystem services: carbon sequestration and water purification provided by mangroves	0	0	0	0	0	0	0	0	No impact
			Variation in cultural services: landscape and recreation.	0	0	0	0	0	0	0	0	No impact
			Impact on soil formation and primary production	0	0	0	0	0	0	0	0	No impact
	Social	Laboral	Risk of occupational accidents	-1	0,1		1		1		-1,1	Slight negative
			Employment generation	1	1					1		Positive
		Community health and safety	Community health impacts: Vectors, traffic, accidental discharges, etc.	-1	0,5			1	1		-5	Moderate negative
			Risks to the safety and health of the population due to infrastructure failures	-1	0,2				0		-2	Slight negative
			Impact on the community, in the event of emergencies and fires	-1	0,1				0		-1	Slight negative
			Risk of human rights violations.	-1	0,1		1	1	0		-0,6	Slight negative

	MEDIO	COMPO-NENTE	IMPACT	Address	Probability	Magnitude	Extension	Duration	Frequency	Reversibility	QUALIFICATION	HIERARCHIZATION
		Community relations	Risk of conflicts with social actors	-1	0,5						-6	Moderate negative
		Socioeconomic	Dynamism of the local economy	1	1							Positive
			Encouraging tourism in Puerto Bolivar and nearby recreational areas	1	0,6						8,4	Positive

3.2. Results of the ranking of potential impacts.

Following the development of the environmental impact assessment, it is concluded that there are impacts categorized as severe, moderate, and mild negative. Severe and mild negative impacts will have priority in the preventive, control, and mitigation measures of the Environmental and Social Management Plan.

Other impacts categorized as mild negative are less significant impacts which can be included in Management Plans insofar as internal or external requirements are in place or as long as there is interest from the parties involved to do so, without said impacts sharing the same level of management urgency as those within more severe categories.

Table 5. *Hierarchy of environmental impacts of YILPORTECU*

PORT OPERATION	IDENTIFIED
Greenhouse gas emissions	-15
Gas emissions from mobile sources (land and maritime)	-8
Particulate matter emissions due to vehicle and machinery operation	-7
Increase in noise and vibration levels due to vehicle and machinery operation	-7
Risk of conflicts with social actors	-6
Alteration in water quality due to effluents or accidental discharges	-5.2
Effects on community health: Vectors, traffic, accidental discharges	-5
Effects on marine flora and fauna due to hazardous substance spills	-3.3
Risk of hazardous substance and hydrocarbon spills into soil	-3
Effects on marine avifauna due to gas, noise, and vibration emissions	-3
Risks on population safety and health due to faulty infrastructure	-2
Potential inappropriate disposal of hazardous waste	-1.2
Risk of hazardous substances and/or contaminants percolation into the subsoil	-1.2
Risk of occupational accidents	-1.1
Effects on the community in the event of emergencies and fires	-1
Effects on marine fauna due to collisions with vessels	-0.8
Potential inappropriate disposal of general waste	-0.6
Risk of human rights violations.	-0.6
Inappropriate disposal of general waste that reaches the sea	-0.4
Variation in food provisioning (fish products)	0
Variation in ecosystem regulating services: carbon sequestration and water purification provided by mangroves	0
Variation in cultural services: landscape and recreation.	0
Impact on soil formation and primary production.	0
Tourism incentive in Puerto Bolívar and nearby recreational areas	8.4
Job creation	12
Invigoration of the local economy	14

CONSTRUCTION	IDENTIFIED
Greenhouse gas emissions	-13
Alteration in air quality due to traffic associated with the supply of construction materials	-8
Particulate matter emissions due to earth and aggregate moving operations	-7
Temporary alteration in benthic fauna due to offshore dredging and works	-5
Effects on community health: Vectors, traffic, accidental discharges	-5
Increase in noise and vibration levels due to heavy machinery operation	-5
Potential effects on dwarf red mangrove remains or loss thereof	-4.5
Lack of job opportunities upon project completion given the temporary nature of the work	-4
Potential hazardous substance spills in offshore works	-3.9
Hazardous substance and hydrocarbon spills	-3.3
Potential effect on archaeological goods in construction activities	-3.3
Risks on population safety and health due to faulty infrastructure	-3
Inappropriate disposal of general waste that reaches the sea	-1.1
Effects on the community in the event of emergencies and fires	-1
Risk of occupational accidents	-0.9
Potential temporary alteration of water quality due to inappropriate disposal of sewage water	-0.6
Risks of violation of human rights.	-0.6
Variation in food supply (fishery products)	0
Job creation	12

DREDGING	IDENTIFIED
Greenhouse gas emissions	-12
Noise and vibration	-7
Temporary alteration in water quality at the dredging disposal site	-5
Alteration in air quality due to gas emissions from the dredge	-5
Temporary alteration in soil quality (seabed) at the dredging disposal site	-5
Temporary impact on marine flora and fauna at the dredging disposal site	-5
Temporary impact on benthic marine fauna at the dredged areas	-5
Variation in food supply (fishery products)	-1.2
Effects on the community in the event of emergencies and fires	-1
Risk of occupational accidents	-0.8
Job creation	7

3.3. Evaluation of residual impacts.

Residual environmental impacts are those that remain despite the environmental measures designed to mitigate them.
The same matrix used for the evaluation of potential environmental impacts will be used for this evaluation, but considering the following particularities:

1. Direction: When a corrective measure is applied, the direction will be 1 (benefit for the resource). If there is no corrective measure, the value of this criterion will be 0.
2. Magnitude: The magnitude of the benefit of the measure will be considered, instead of the detriment of the impact.
3. Reversibility: the possibility of nullifying the beneficial effects of the corrective measure by some action or omission, or the possibility of returning to the conditions prior to the application of the measure.
4. For the rest of the evaluation criteria: geographic extension, probability, duration and frequency, the assessment is made considering the value of the corrective measure in relation to the corresponding environmental impact, therefore, these values must be less than or equal to the potential impact evaluated.
5. The coding of the applicable Program and/or Plan is included, PMS if it is from the Environmental Management Plans in force in the respective environmental licenses (Operation, Dredging, and Pier 6), and PGAS if the measures correspond to the Environmental and Social Management Plan of this study (see Book VII).

The residual impact will result from the subtraction between the potential environmental impact and the environmental impact after the applied corrective measures.

The results of this analysis are shown in the following matrix:

Matrix 2. Residual environmental and social impact assessment

	MEDIO	COMPO-NENTE	IMPACT	POTENTIAL IMPACT	ENVIRONMENTAL ACTION	Address	Probability	Magnitude	Extension	Duration	Frequency	Reversibility	IMPACT THEN MEASURES	RESIDUAL EFFECT	HIERARCHY
OPERATION	Physicist	Water	Poor disposal of common wastes that end up in the sea	-0,4	PMA Operation PMD-01	1	0,05	1	1		1	1	0,35	-0,05	Slight negative
			Alteration of water quality due to effluents or accidental spills	-5,2	PMA Operation PPM-02 PMS-02 PMS-02	1	0,2		1			1		-3,2	Slight negative
		Air	Gaseous emissions from mobile sources (land and marine)	-8	PMA Operation PPM-01 PMS-01 PMS-01	1	1	1	1	1	1	1	5	-3	Slight negative
			Greenhouse gas emissions	-15	Carbon Neutral Certification	1	1							-4	Slight negative
			Particulate matter emissions from vehicle and machinery operation	-7	PMA Operation PPM-01 PMS-01 PMS-01	1	1	1		1		0		-1	Slight negative
			Increase in noise and vibration levels due to operation of vehicles and machinery	-7	PMA Operation PPM-01 PMS-01 PMS-01	1	1		1	1		0		-1	Slight negative
		Soil	Possible poor disposal of common waste	-0,6	PMA Operation PMD-01	1	0,1	1	1	1		1	0,6	0	No impact
			Possible improper disposal of hazardous waste	-1,2	PMA Operation PMD-02	1	0,1						1,2	0	No impact
			Risks of spills of hazardous substances and hydrocarbons on the ground.	-3	PMA Operation PPM-03PGAS (8)	1	0,25	1	1		1	1	1,75	-1,25	Slight negative

	MEDIO	COMPO-NENTE	IMPACT	POTENTIAL IMPACT	ENVIRONMENTAL ACTION	Address	Probability	Magnitude	Extension	Duration	Frequency	Reversibility	IMPACT THEN MEASURES	RESIDUAL EFFECT	HIERARCHY
			Risk of infiltration of hazardous substances and/or contaminants into the subsoil.	-1,2	PMA Operation PPM-03PGAS (8)	1	0,1	1	1			1	0,8	-0,4	Slight negative
	Biotic	Marine fauna	Impact on marine fauna due to collision with vessels	-0,8	PGAS (9.4.)	1	0,1	1	1	1	1	1	0,5	-0,3	Slight negative
		Coastal marine flora and fauna	Impact on marine flora and fauna due to hazardous substance spills	-3,3	PMA Operation PMD-02 PMS-02 PGAS (8, 9, 14)	1	0,3	1	1			1	2,1	-1,2	Slight negative
		Coastal marine avifauna	Impact on marine avifauna due to gas emissions, noise and vibrations.	-3	PMA Operation PPM-01	1	0,3	1	1			1	2,4	-0,6	Slight negative
		Ecosystem services	Variation in food supply (fishery products)	0	PGAS (9.3.4.4., 9.3.4.6.)	0	0	0	0	0	0	0	0	0	No impact
			Variation in regulating ecosystem services: carbon sequestration and water purification provided by mangroves	0	PGAS (9.5., 9.3.4.6.)	0	0	0	0	0	0	0	0	0	No impact
			Variation in cultural services: landscape and recreation.	0		0	0	0	0	0	0	0	0	0	No impact
			Impact on soil formation and primary production	0		0	0	0	0	0	0	0	0	0	No impact
	Social	Laboral	Risk of occupational accidents	-1,1	PMA Operation PEC-01	1	0,1		1		1		0,9	-0,2	Slight negative

	MEDIO	COMPO-NENTE	IMPACT	POTENTIAL IMPACT	ENVIRONMENTAL ACTION	Address	Probability	Magnitude	Extension	Duration	Frequency	Reversibility	IMPACT THEN MEASURES	RESIDUAL EFFECT	HIERARCHY
			Employment generation			0	1					1	0		Positive
		Community health and safety	Community health impacts: Vectors, traffic, accidental discharges, etc.	-5	PMA Operation PEC-01 PRA-01PGAS (13)	1	0,5		1	1	1	1		-2	Slight negative
			Risks to the safety and health of the population due to infrastructure failures	-2	PMA Operation PEC-01 PRA-02PGAS (13.5.3.)	1	0,2		1		0	1	1,2	-0,8	Slight negative
			Impact on the community, in the event of emergencies and fires	-1	LDC Operation PEC-01 PRA-03PGAS (13.5.4.)	1	0,1		1		0	1	0,7	-0,3	Slight negative
			Risk of human rights violations.	-0,6	PGAS (13.5.5., 14)	1	0,1		1	1	0		0,6	0	No impact
		Community relations	Risk of conflicts with social actors	-6	PMA Operation PRC-01PGAS (6., 17.)	1	0,5					1	5	-1	Slight negative
		Socioeconomic	Dynamism of the local economy			0	1						0		Positive
			Encouraging tourism in Puerto Bolivar and nearby recreational areas	8,4		0	0,6						0	8,4	Positive
CONSTRUCTION	**Physicist**	Water	Possible temporary alteration of water quality due to improper sewage disposal	-0,6	PMA Pier 6 PPMI-C-03PGAS (12.4.)	1	0,1	1	1	1		0	0,5	-0,1	Slight negative
			Poor disposal of common wastes that end up in the sea	-1,1	PMA Pier 6 PPMI-C-02, PMD-C-01 to 04, PMD-O-01 to 04PGAS (12.5.)	1	0,1	1	1			1	0,7	-0,4	Slight negative

	MEDIO	COMPO-NENTE	IMPACT	POTENTIAL IMPACT	ENVIRONMENTAL ACTION	Address	Probability	Magnitude	Extension	Duration	Frequency	Reversibility	IMPACT THEN MEASURES	RESIDUAL EFFECT	HIERARCHY
			Possible spills of hazardous substances in offshore works	-3,9	PMA Pier 6 PDC-C-01 PDC-C-04PGAS (12.8.)	1	0,3	1	1			1	2,4	-1,5	Slight negative
		Air	Alteration of air quality due to increased traffic for the supply of construction materials.	-8	PMA Pier 6 PPMI-C-04, PPMI-O-02	1	1	1	1	1		0	5	-3	Slight negative
			Greenhouse gas emissions	-13		0	1	0				0	0	-13	High negative
			Particulate matter emissions from earth and aggregate movements	-7	PMA Pier 6 PPMI-C-04, PPMI-O-02	1	1	1	1	1		0	5	-2	Slight negative
			Elevated noise and vibration levels due to heavy machinery operation	-7	PMA Pier 6 PPMI-C-04, PPMI-O-02PGAS (12.7.)	1	1	1	1	1		0	5	-2	Slight negative
		Soil	Spills of hazardous substances and hydrocarbons	-3,3	PMA Pier 6 PDC-C-01	1	0,3	1	1				2,4	-0,9	Slight negative
	Biotic	Flora-mangrove	Possible impact or loss of remnants of dwarf red mangroves	-4,5	PGAS (9.5.)	1	0,5		1		1		4,5	0	No impact
		Benthic fauna	Temporary alteration of benthic fauna by dredging and offshore work	-4		0	1	1	1	1		0	0	-4	Slight negative
		Marine mammals	Impact to marine fauna by underwater noise due to pile driving	-4	PGAS (12.7.1.)	1	0,5	0	1	1	1	0	1,5	-2,5	Slight negative
		Ecosystem services	Variation in food supply (fishery products)	0	PGAS (9.3.4.3., 9.3.4.4., 9.3.4.6.)	0	0	0	0	0	0	0	0	0	No impact
	Social	Laboral	Risk of occupational accidents	-0,9	PMA Pier 6 PPMI-C-05, PPMI-O-03	1	0,1	1	1			1	0,7	-0,2	Slight negative

	MEDIO	COMPO-NENTE	IMPACT	POTENTIAL IMPACT	ENVIRONMENTAL ACTION	Address	Probability	Magnitude	Extension	Duration	Frequency	Reversibility	IMPACT THEN MEASURES	RESIDUAL EFFECT	HIERARCHY
			Employment generation		PMA Pier 6 PRC-C-01	1	1	1	1	1		1			Positive
		Community health and safety	Community health impacts: Vectors, traffic, accidental discharges, etc.	-5	PMA Pier 6 PMD-O-02 PRC-C-02PGAS (6.)	1	0,5	1		1	1			-1	Slight negative
			Risks to the safety and health of the population due to infrastructure failures	-3	PMA Pier 6 PDC-C-03, PDC-O-03PGAS (13.5.3.)	1	0,3	1			0		2,4	-0,6	Slight negative
			Impact on the community, in the event of emergencies and fires	-1	PMA Pier 6 PDC-C-03, PDC-O-04PGAS (13.5.4.)	1	0,1	1			0		0,8	-0,2	Slight negative
			Risk of human rights violations	-0,6	PGAS (13.5.5., 14)	1	0,1		1	1	0		0,6	0	No impact
		Temporary workforce	Shortage of job opportunities due to the temporary nature of the work, once the project has been completed.	-4	PGAS (16.)	1	0,5	1	1			1		0	No impact
		Patrimonial	Possible impact on archaeological properties in construction activities	-3,3	PGAS (10.)	1	0,3		1		1			-0,3	Slight negative
DRAGADO	Physicist	Water	Temporary alteration of water quality in dredging reservoir area	-5	PMA Dredging PPM-02 PMS-02	1	0,5	1	1	1		0	2,5	-2,5	Slight negative
		Air	Alteration of air quality due to gas emissions from the dredge	-5	PMA Dredging PPM-01 PMS-01	1	0,5	1	1	1		0	2,5	-2,5	Slight negative
			Greenhouse gas emissions	-12		0	1			1			0	-12	High negative
			Increase in noise and vibration levels due to	-7	PMA Dredging PPM-01	1	1	1		1		0		-1	Slight negative

	MEDIO	COMPO-NENTE	IMPACT	POTENTIAL IMPACT	ENVIRONMENTAL ACTION	Address	Probability	Magnitude	Extension	Duration	Frequency	Reversibility	IMPACT THEN MEASURES	RESIDUAL EFFECT	HIERARCHY
			operation of vehicles and machinery												
		Soil	Temporary alteration of soil quality (seabed) in dredge deposit area	-5	PMA Dredging PMS-03	1	0,8	1	1	1		0		-1	Slight negative
	Biotic	Marine fauna	Temporary impact on the marine flora and fauna in the dredging deposit area.	-5	PMA Dredging PPM-05 PMS-06 PMS-07 PMS-08 PMS-08	1	0,8	1	1	1		0		-1	Slight negative
		Benthic fauna	Temporary impact on the benthic marine fauna in dredged areas.	-5	PMA Dredging PPM-05 PMS-06 PMS-07 PMS-08 PMS-08	1	0,8	1	1	1		0		-1	Slight negative
		Ecosystem services	Variation in food supply (fishery products)	-1,2	PMA Dredging PPM-04 PCC-02 PMS-03 PMS-04	1	0,1		1	1		0	0,6	-0,6	Slight negative
	Social	Laboral	Risk of occupational accidents	-0,8	LDC Dredging PCC-01 PEC-01 PSS-01	1	0,1	1	1	1			0,7	-0,1	Slight negative
			Employment generation			0	1		1	1		1	0		Positive
		Community health and safety	Impact on the community, in the event of emergencies and fires	-1	PMA Dredging PCC-02 PRC-01 PRC-02 PMS-09	1	0,1	1			0		0,8	-0,2	Slight negative

3.4. Results of the ranking of residual impacts.

The results of the ranking of residual impacts are shown below, where many of the impacts for which corrective measures have been designed, significantly decrease their value.

Table 6. Hierarchy of residual environmental impacts of YILPORTECU S.A.

PORT OPERATION	POTENTIAL IMPACT	RESIDUAL EFFECT
Greenhouse gas emissions	-15	-4
Alteration of water quality due to effluents or accidental spills	-5,2	-3,2
Gaseous emissions from mobile sources (land and marine)	-8	-3
Community health impacts: Vectors, traffic, accidental discharges, etc.	-5	-2
Risks of spills of hazardous substances and hydrocarbons on the ground.	-3	-1,25
Impact on marine flora and fauna due to hazardous substance spills	-3,3	-1,2
Particulate matter emissions from vehicle and machinery operation	-7	-1
Increase in noise and vibration levels due to operation of vehicles and machinery	-7	-1
Risk of conflicts with social actors	-6	-1
Risks to the safety and health of the population due to infrastructure failures	-2	-0,8
Impact on marine avifauna due to gas emissions, noise and vibrations.	-3	-0,6
Risk of infiltration of hazardous substances and/or contaminants into the subsoil.	-1,2	-0,4
Impact on marine fauna due to collision with vessels	-0,8	-0,3
Impact on the community, in the event of emergencies and fires	-1	-0,3
Risk of occupational accidents	-1,1	-0,2
Poor disposal of common wastes that end up in the sea	-0,4	-0,05
Possible poor disposal of common waste	-0,6	0
Possible improper disposal of hazardous waste	-1,2	0
Variation in food supply (fishery products)	0	0
Variation in regulating ecosystem services: carbon sequestration and water purification provided by mangroves	0	0
Variation in cultural services: landscape and recreation.	0	0
Impact on soil formation and primary production	0	0
Risks of human rights violations.	-0,6	0
Encouraging tourism in Puerto Bolivar and nearby recreational areas	8,4	8,4
Employment generation		
Dynamism of the local economy		

CONSTRUCTION	POTENTIAL IMPACT	RESIDUAL EFFECT
Greenhouse gas emissions	-13	-13
Temporary alteration of benthic fauna by dredging and offshore work	-4	-4
Alteration of air quality due to increased traffic for the supply of construction materials.	-8	-3
Impact on marine fauna by underwater noise due to pile driving	-4	-2,5
Particulate matter emissions from earth and aggregate movements	-7	-2
Elevated noise and vibration levels due to heavy machinery operation	-7	-2
Possible spills of hazardous substances in offshore works	-3,9	-1,5
Community health impacts: Vectors, traffic, accidental discharges, etc.	-5	-1

CONSTRUCTION	POTENTIAL IMPACT	RESIDUAL EFFECT
Spills of hazardous substances and hydrocarbons	-3,3	-0,9
Risks to the safety and health of the population due to infrastructure failures	-3	-0,6
Poor disposal of common wastes that end up in the sea	-1,1	-0,4
Possible impact on archaeological properties in construction activities	-3,3	-0,3
Risk of occupational accidents	-0,9	-0,2
Impact on the community, in the event of emergencies and fires	-1	-0,2
Possible temporary alteration of water quality due to improper sewage disposal	-0,6	-0,1
Possible impact or loss of remnants of dwarf red mangroves	-4,5	0
Variation in food supply (fishery products)	0	0
Risk of human rights violations	-0,6	0
Shortage of job opportunities due to the temporary nature of the work, once the project has been completed.	-4	0
Employment generation		

DRAGADO	POTENTIAL IMPACT	RESIDUAL EFFECT
Greenhouse gas emissions	-12	-12
Temporary alteration of water quality in dredging reservoir area	-5	-2,5
Alteration of air quality due to gas emissions from the dredge	-5	-2,5
Increase in noise and vibration levels due to operation of vehicles and machinery	-7	-1
Temporary alteration of soil quality (seabed) in dredge deposit area	-5	-1
Temporary impact on the marine flora and fauna in the dredging deposit area.	-5	-1
Temporary impact on the benthic marine fauna in dredged areas.	-5	-1
Variation in food supply (fishery products)	-1,2	-0,6
Impact on the community, in the event of emergencies and fires	-1	-0,2
Risk of occupational accidents	-0,8	-0,1
Employment generation		

4. CONCLUSIONS

An environmental and social impact assessment has been conducted, which first identified potential impacts based on the current and future activities and operations of YILPORTECU S.A. while considering the distinctive features of its area of influence.

The results of the evaluation of potential impacts show that, for the most part, the impacts identified are rated moderate and slight. Severe negative impacts are related to greenhouse gas emissions due to their cumulative and irreversible nature and their global expanse.

Other high impacts are those related to emissions caused by transportation and machinery operation, which affect air quality. Also, there are positive environmental and social impacts associated with creating jobs and the invigoration of the economy as a result of an international port operation in the area of influence.

The evaluation of residual environmental impacts shows that the vast majority of environmental and social impacts significantly decrease their value, leaving all of them in the category of slight negative in all phases of the project, since preventive and corrective measures are in place. In some cases the impacts can be easily nullified with the implementation of corrective measures, as in the case of common and hazardous waste management, or reduced to almost zero, as in the case of occupational accidents, spills of hazardous substances, or other types of emergencies.

Regarding the emission of greenhouse gases, which is the impact that maintains the highest values, it is recommended to include actions aimed at changing energy sources in the operations in which YILPORTECU S.A. has an impact, considering including machinery and vehicles powered by electric energy, or the provision of facilities that use alternative energy sources such as solar or wind power.

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT
PUERTO BOLÍVAR – STAGE 1

– IDENTIFICATION AND ASSESSMENT OF CUMULATIVE IMPACTS –

Prepared for:

[Yilport Puerto Bolívar logo composite mark]

YILPORT TERMINAL OPERATIONS, YILPORTECU S.A

Prepared by:

[Sambito logo composite mark]

ECOSAMBITO C.LTDA.

December 2020

Table of contents

Table index

Figure index

Photographic records index

EXECUTIVE SUMMARY

Cumulative impact assessment and management (EGIA) is conducted in accordance with the requirements set forth in Performance Standard 1: Assessment and management of environmental and social risks and impacts of the International Finance Corporation, which acknowledges the urge to manage increasing and systemic risks such as climate change, biodiversity loss and environmental services decline, among others.

Puerto Bolívar Expansion Project Stage 1, as is the case with most port projects, is carried out in a location where several undertakings converge, many of which will benefit from the logistic advantages and international business opportunities that these regional impact structures offer. These activities, that have been taking place and increasing in number and level of impact and which have drastically changed the Project area of influence throughout at least 5 decades, have contributed to the current state of environmental quality. Current and future projects, including that which is the subject of this assessment, will cumulatively contribute to the deterioration of the environmental quality of this region, hence the need for identifying each of their individual contributions to potential future alterations in the ecosystem so as to avoid causing irreversible damages to the environmental and ecological balance.

A limited spatial scope was defined for the development of EGIA in relation to the Area of Direct and Indirect Influence set out in the Environmental and Social Impact Assessment, as well as a 50-year time frame which encompasses the entire term of Yilportecu's operating license to the Port Terminal. The current state of Environmental and Social Components (CASs) identified in the environmental impact analysis of the Environmental and Social Impact Assessment (EIAS) is revised and described in subsequent steps, and the contributions of the interested parties are included for validation purposes. Preexisting, current and future undertakings carried out in the project vicinity are identified and, by means of an interaction matrix, an estimate of the contribution of each project or undertaking—both new and with incremental tendency—to the CASs is calculated, thereby establishing the Valued Environmental and Social Components (VECs). Finally, the significance and hierarchy of the cumulative impacts of said undertakings on the defined VECs is assessed.

Results show that Puerto Bolívar Expansion Project Stage 1 has a limited contribution to the cumulative impacts on VECs since their effects are localized and their expansion does not pose any significant threats to biodiversity. This assessment shows that preexisting activities such as mining and aquaculture are undergoing an escalation phase, undertakings which contribute in a proportionally higher degree to affecting VECs in the assessed area.

Assessment of cumulative impacts associated with Puerto Bolívar Expansion Project Stage 1

1. Introduction

According to the text “Guía para evaluar y gestionar los impactos y riesgos para la biodiversidad en los proyectos respaldados por el Banco Interamericano de Desarrollo” (Watkins et al, 2015), cumulative impacts are the product of combined effects on the essential characteristics of biodiversity (or on valuable components of the ecosystem to which they are related) of all previous, current and reasonably foreseeable projects.

Said authors maintained that the cumulative impact assessment is usually overlooked during projects and the fact that these are difficult to mitigate is partly to blame, since the program or client may consider that the management of said impacts is the regional or national government responsibility. Although it may be more effective to address such impacts at the local, regional or national level, clients must include—through strategic environmental assessments or regional planning programs—a cumulative impact assessment in the global EA process.

A more straightforward definition for understanding cumulative effects/impacts is that of Hegmann et al. (1999), who states that “cumulative effects are defined as changes in the environment caused by an action in conjunction with other past, current and future actions”.

Cumulative impacts are contextual and cover a wide range of impacts at different spatial and temporal levels. Cumulative impact assessments must be centered around the combined and incremental effects of the project and other undertakings, programs or activities on the quality of the natural environment.

Puerto Bolívar Expansion Project Stage 1 is directly related to Estero Santa Rosa marine coastal environment and its open sea outlet through Canal de Jambelí, until the dredged sediment disposal basin (approximately 13.75 miles from the sea buoy), where intermittent and specific effects associated with the performance of dredging activities would be produced. However, from an ecological perspective, delimitations in the areas of influence constitute practices limited to the physical dynamics of local currents and their reach within a given time frame, e.g. so as to take precautions concerning the outcomes of chemical events, provided these are produced in the jurisdictional water surface or maneuvering areas facing the port, or otherwise caused by port tugboats.

The environment in which the project is carried out, i.e. the continental margin of Estero Santa Rosa and Canal de Jambelí, serves as an overview of cumulative impacts since colonial times, when the city of Guayaquil was officially founded on 25 June 1537, year in which the indigenous Machala settlement was discovered and subsequently named Cantón Machala on 25 June 1824, and whose natural border towards the sea was formed by the area that is now known as Puerto Bolívar. Development throughout decades of port activity and other important productive activities (undertakings), as well as the pressure exerted by population growth,

which currently reaches around one third of a million residents in the area of influence, together with the lack of wastewater treatment systems, result in a highly altered environment.

2. Scope and goals

This cumulative impacts report covers all activities associated with Puerto Bolívar Port Terminal Expansion Project and other activities performed within its area of direct and indirect influence during a 50-year time frame.

This report expects to reach the following goals:

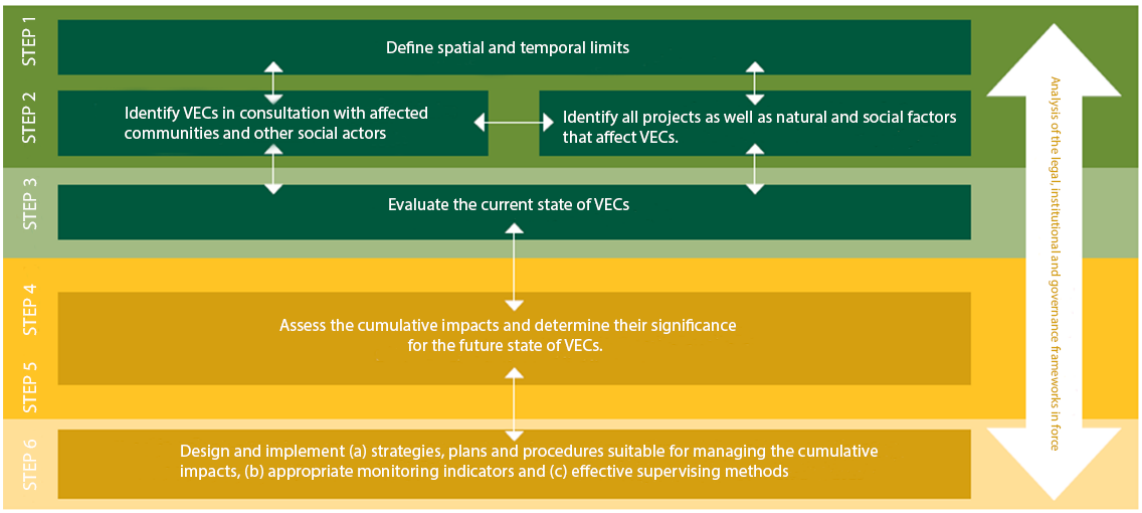
- Identify VECs that take cumulative impacts within the spatial and temporal boundaries of the assessment while ensuring that the concerns and interests of social actors are being taken into consideration.
- Asses potential risks and impacts of the project and other undertakings within the area of influence on each VEC.
- Determine the contribution to cumulative impacts of previous and future undertakings on each VEC.
- Based on the nature and scale of cumulative social and environmental impacts produced by the undertakings, implement practical measures aimed at preventing, minimizing and mitigating those impacts.

3. Methodology.

This report adheres to the guiding document: Good practice manual, Assessment and management of cumulative impacts: A guide for the private sector in emerging markets, digital publication of the International Finance Corporation of the World Bank Group (IFC, 2015). Said guideline is based on a methodology of 6 steps or main assessments, which are as follows:

- **Step 1:** Identify the Valued Environmental and Social Components (VECs), in consultation with social actors. Define spatial and temporal limits
- **Step 2:** Determine whether there are other past, present or in-development activities within the area or time frame stipulated for the assessment.
- **Step 3:** Determine the current state of or baseline for VECs.
- **Steps 4 and 5:** Assess the cumulative impacts and determine their significance for the future state of VECs; and lastly,
- **Step 6:** Design and implement: a) strategies, plans and procedures suitable for managing cumulative impacts; b) appropriate monitoring indicators, and c) effective supervising methods.

Figure 1. Logical framework for a quick EGIA



Source: IFC, 2015

A hindrance for developing this methodology in Puerto Bolívar Expansion Project Stage 1 lies in that the information relative to the cumulative impacts of undertakings in the Machala-Puerto Bolívar conurbation is scattered, and represents a sensitive issue for the corporate image of undertakings and institutions which do not wish to be associated in the collective unconscious with a harmful activity to the natural environment. Moreover, there is hardly any information at hand and/or publicly available which allows for assessing and subdividing the cumulative impacts of undertakings, particularly in areas regarded as strategic by the Ecuadorian government, nor have any rigorous monitoring procedures been performed in relation to particular or sector-specific cumulative impacts in the area of influence.

4. Definition of preliminary geographical and temporal limits for EGIA

4.1. Definition of spatial limits

The geographical limits are defined in the areas of direct (AID) and indirect influence (AII) of Puerto Bolívar Expansion Project Stage 1, and specified in the chapter devoted to areas of influence. The project areas of influence were established based on the interactions between components, aspects and potential environmental impacts, elements on which the identification of valued socio-environmental components is grounded. Therefore, it is reasonable to conclude that all the VECs assessed in this document are within the geographical limits.

Since port activities have a major role in the marine coastal environment, the areas of influence were defined according to oceanographic criteria, physical and biological aspects. It was calculated that local tidal drag in relation to a local “syzygy” or “spring tide” would have an estimated surface drag displacement of 13.34 km, the same that is based on the descriptions of approaching surface speeds to Puerto bolivar outlined in Publication 125 “*Sailing directions*

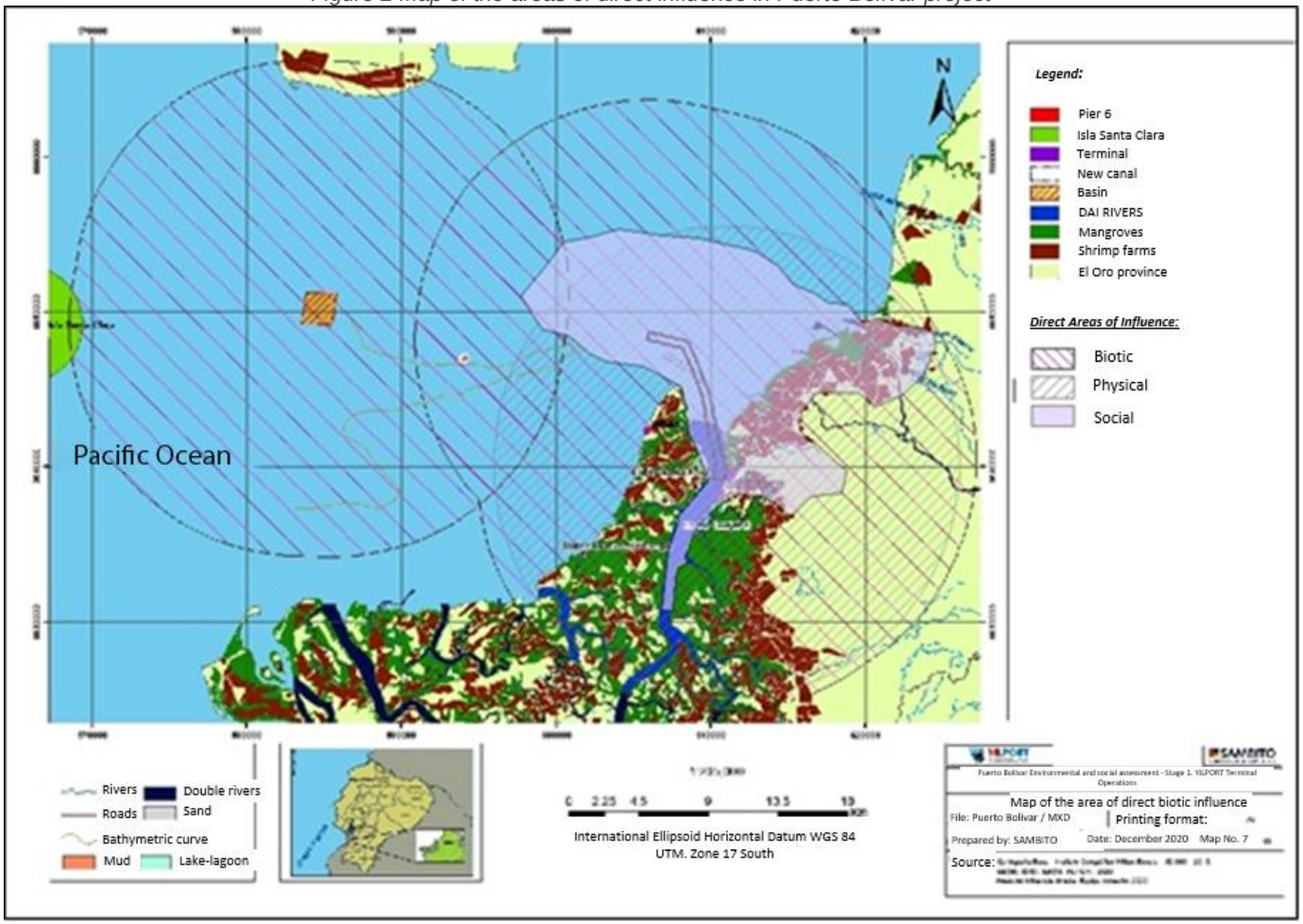
(enroute) West Coast of South America", Fifteenth edition (2017) of the United States National Geospatial-Intelligence Agency. This calculation was rounded off to a 15 km buffer as water drift from vertices georeferenced as AID in bodies of water, while also taking into consideration the biological connectivity of marine regions with similar depth levels and intertidal influence towards the continent until reaching the internal borders in the remnants of mangrove forests which have not been replaced by shrimp farming ponds.

The area of indirect influence includes a strip of 5 km around the AID in bodies of water, and of 1 km in land due to the geographical barriers in the continental area (associated with coastal plains' main lands). The AII spatial limits encompassing most of the area pertain to the project biophysical area of influence, and are placed in the terrain by:

North: Canal de Jambelí and Isla Puná (Guayaquil-Guayas).
South: Estero Jumón and Estero Pital (Cantón Santa Rosa and Arenillas in El Oro province).
East: Estero San Ramón (Cantón Guabo and Pasaje in El Oro province).
West: The Pacific Ocean and Isla Santa Clara

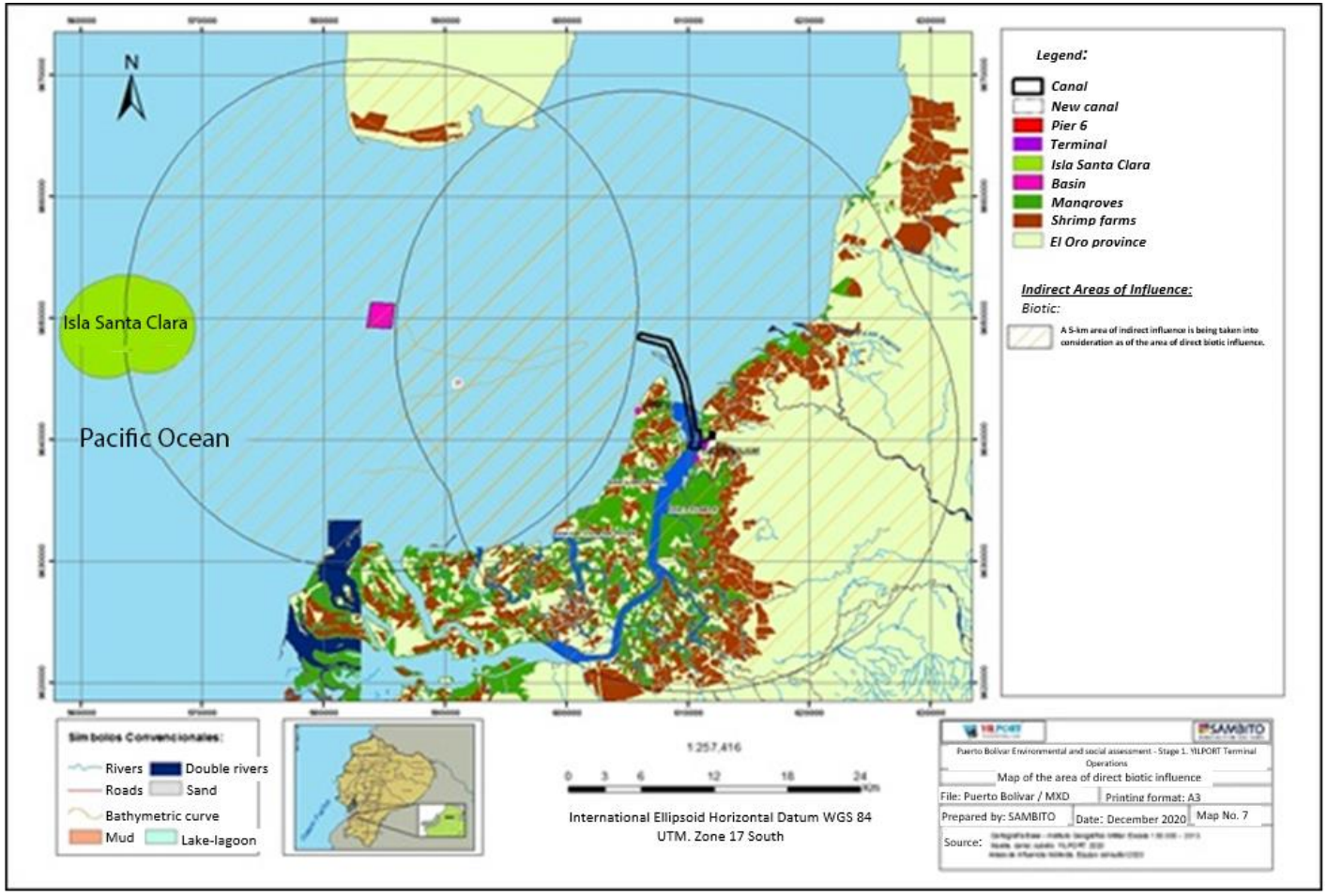
The detailed representation of the physical, biotic and social areas of influence in Puerto Bolívar Project is shown in Figures 2 and 3.

Figure 2 Map of the areas of direct influence in Puerto Bolívar project



Prepared by: Ecosambito, 2020

Figure 3. Map of the areas of indirect influence in Puerto Bolívar project

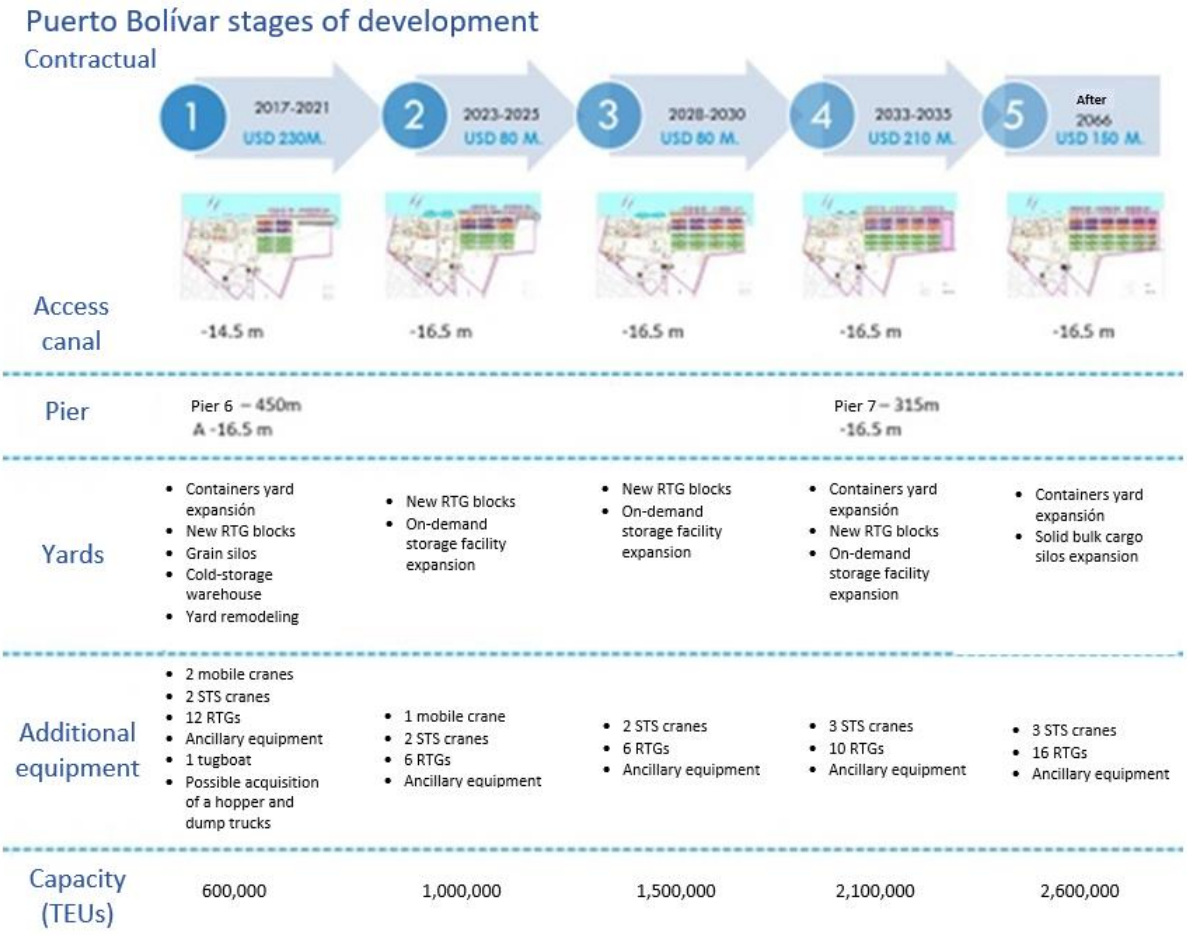


Prepared by: Ecosambito, 2020

4.2. Definition of temporal limits

As to the project temporal limits, the duration of Yilportecu's port operating license to Puerto Bolívar is 50 years. During said period, the Port Terminal is envisioned to undergo a five-stage expansion. Figure 4 shows the main works and capacities that are expected to be accomplished (prospects of growth in TEU load handling) and which will serve as "triggers" for the next stages. It is expected that by the year 2066 the operating capacity will have reached 2,600,000 TEU.

Figure 4. Main activities and temporal projections of Puerto Bolívar project



Source: Yilportecu S.A.

5. Definition of VECs

VECs are environmental and social attributes that are considered significant in impact and risk assessments, and may be:

- physical characteristics, habitats, wildlife populations (e.g. biodiversity),
- environmental services,
- natural processes (e.g. Water and nutrient cycles, microclimates),
- social conditions (e.g. Health, economy), or
- cultural aspects (e.g. spiritual or traditional ceremonies).

Although VECs may be directly or indirectly affected by a specific undertaking, they may also be affected on a regular basis by cumulative effects produced by other undertakings. VECs are the integrated recipients of cumulative impacts because they are generally located at the end of ecological processes.

The first action in order to identify VECs is to perform a preliminary identification in which the Environmental Components obtained from the EIAS Environmental Impact Assessment are studied, followed by the observation of Environmental Components which, according to the social actors, would potentially be affected by the project. The definitive VECs will be a subassembly of the ones identified in the EIAS and those which are also a matter of concern to the community.

5.1. Identification of Environmental Components

In the Environmental Impact Assessment of the Project EIAS, aspects and impacts have been identified for every stage. Environmental aspects are regarded as those elements of the activity, product or service that interact with environmental elements (water, air, community, etc.), causing changes or alterations in the socio-environmental component.

Table 1. Identification of VECs from the Environmental Impact Assessment.

Environmental Element	Environmental Aspect	Identified Socio-environmental Component
Water, soil	General waste production	Water and sediment quality
Water, soil	Sewage water production	Water and sediment quality
Water, soil	Water quality in effluents or accidental discharges	Water and sediment quality
Water, soil, biotic (marine and coastal flora and fauna)	Storage and use of hazardous materials	Water and sediment quality
		Soil quality
		Biodiversity
Air, Social (community health and safety)	Land traffic and port machinery operation	Air quality
		Noise
		Land traffic
		Community health and safety
Air, biotic (marine fauna)	Port traffic	Biodiversity
		Air quality
		Maritime traffic
Social (occupational)	Workforce	Economy
Social (occupational)	Temporary workforce	Economy

Environmental Element	Environmental Aspect	Identified Socio-environmental Component
Social	Interaction with social actors	Community relations
Social (community health)	Port activities	Community health and safety
Social (economy)	Trade and services	Economy
Social (economy)	Landscape quality	Tourism
Biotic (Mangrove)	Variations in current patterns and sediments	Biodiversity (mangrove)
Biotic (benthic fauna)	Seabed dredging	Water quality
		Biodiversity
Biotic (marine mammals)	Underwater noise	Biodiversity
Social (community health and safety)	Community health and safety	Community health and safety
Social (Cultural heritage)	Excavations	Cultural heritage
Water, Soil, biotic (marine fauna), Social (economic)	Extraction and disposal of seabed dredged material Dredge operation Fishery	Biodiversity
		Fisheries

Prepared by: Ecosambito, 2020

Impacts affect several aspects or portions of the Environmental Components; these have been grouped into 12, as listed below:

1. Water and sediment quality
2. Air quality and noise
3. Soil quality
4. Land traffic
5. Maritime traffic
6. Biodiversity
7. Community health and safety
8. Community relations
9. Economy
10. Tourism
11. Cultural heritage
12. Fisheries

5.2. Environmental Components identified through consultation methods.

In November 2020, during the Social Baseline survey conducted in the area of influence, 84 people from different neighborhoods and social organizations in Puerto Bolívar were interviewed, including residents of the neighborhoods adjacent to the Project and the presidents of associations Cuevas del Huayco, Puerto Nuevo and Asociación de Mujeres Estero Porteño. Upon consulting which project activities are of greater concern to the interviewees, the most relevant aspect was the issue involving the dredging of the access canal to Puerto Bolívar. The advantages and disadvantages identified by the interviewees are summarized in Table 2.

Besides the interviews, an informational workshop was held during the same month with representatives of Unión de Organizaciones de Producción Pesquera Artesanal de El Oro (UOPAO), Cooperativa de Producción Pesquera Artesanal Vikingos del Mar, and Organización Comunitaria de Servicios Turísticos La Playita. The main focus of the comments and observations made therein was the potential harm of dredging activities.

Table 2. Interested parties' criteria regarding the project advantages and disadvantages.

Interviews with residents	
Advantages	**Disadvantages**
• Creates more jobs • Increases tourism • Improves the canal • Improves the access to Jambelí • Boosts commerce • Minimizes bad odors • Entry of large vessels • Improvement in boat traffic • Increased productivity and trade • Greater recognition of Puerto Bolívar • Economic growth in the parish	• Harmful to nature • Detrimental to fishermen • Damages the ecosystem • Affects the species • Heavy swell • Dispels marine species • Disappearance of shrimps • Busy traffic in the area • Seabed damage • Imbalance in animal life • Environmental impact
Workshop with Fishermen Associations	
Advantages	**Disadvantages**
• Development	• Lack of socialization with the fishery industry • Impact on mollusks and shrimp fishing • Impact on fish and fish migration • Restrictions on fishing areas due to dredging activities • Suspended sediments on water, nets covered in mud.

Prepared by: Ecosambito, 2020

Some of the interested parties' perceptions are specific, while others are more general. Table 3 shows how those perceptions relate to their equivalent environmental components.

Table 3. Identification of VECs from a social perspective.

Citizen views (project advantages and disadvantages)	**Identified social and environmental component**
Creates more jobs	Economy
Increases tourism	Tourism
Improves the canal	Maritime traffic
Improves the access to Jambelí	Maritime traffic
Boosts commerce	Economy
Minimizes bad odors	Odors
Entry of large vessels	Maritime traffic

Citizen views (project advantages and disadvantages)	Identified social and environmental component
Improvement in boat traffic	Maritime traffic
Increased productivity and trade	Economy
Greater recognition of Puerto Bolívar	Economy and tourism
Economic growth in the parish	Economy
Harmful to nature	Biodiversity
Detrimental to fishermen	Fisheries
Damages the ecosystem	Biodiversity
Affects the species	Biodiversity
Heavy swell	Maritime traffic
Dispels marine species	Biodiversity
Disappearance of shrimps	Biodiversity and fisheries
Busy traffic in the area	Maritime traffic
Seabed damage	Biodiversity
Imbalance in animal life	Biodiversity
Environmental impact	Water and sediment quality, biodiversity
Development	Economy
Lack of socialization with the fishing industry	Fisheries
Impact on mollusks and shrimp fishing	Biodiversity
Impact on fish and fish migration	Fisheries
Restrictions on fishing areas due to dredging activities	Fisheries
Suspended sediments on water, nets covered in mud.	Water and fishery quality

Prepared by: Ecosambito, 2020

Once again, the Environmental Components identified by the community repeat. As a result, Table 3 is summarized in the following Environmental Components:

1. Tourism
2. Economy
3. Odors
4. Biodiversity
5. Fisheries
6. Maritime traffic

The above list is a subassembly of Environmental Components identified and assessed in the EIAS, with the exception of odors, which could be included in the air quality component; however, besides having been regarded as a positive impact, it has not been previously evaluated as such, which is why it is not included in the assessment.

5.3. Determination of the current state of Environmental Components.

The aforementioned components were described using the information gathered in the EIAS baseline survey as well as the environmental assessments and monitoring procedures of the project environmental tracking.

5.3.1. Water and sediment quality

A record of 15 reports is kept on marine waters and sediments within the project area of direct influence. Monitoring procedures are performed quarterly in the following locations, and monthly during the months in which dredging activities take place:

1. In front of Puerto Bolívar Port Authority (APPB)
2. In front of Naval School
3. Isla del Amor
4. Entrance to El Coco
5. Punta El Faro
6. Entrance to Jambelí

Marine water quality.

Dissolved oxygen: This variable is kept within the range laid down in the environmental legislation. Overall, the closer the stations are to the sea access, the higher the oxygen level, which is expected given the conditions of Estero Santa Rosa inner waters. A reduction of oxygen is observed in the second dredging period.

Oxygen saturation: this criterion correlates to the oxygen reduction seen during the performance of dredging activities; but saturation values above 90% are detected nonetheless, which *a priori* is interpreted as good water quality.

Total suspended solids: This variable shows an increase near mangrove areas with higher mean values towards the Isla Jambelí region.

Ammonium-N**.** This variable is associated with organic enrichment and shows its highest values in the sample near the APPB pier dated August 2019. Said variable, identified in literature as one of the main impacts of dredging activities, does not show an increase during dredging stages. In general, its values are far below the limits laid down in the environmental legislation.

Ammonia-N: From a sector-specific perspective, this variable shows a higher concentration at Isla Jambelí sites, although the highest measurement was recorded in station P1, as was the case with ammonium, in August 2019.

Biochemical oxygen demand: most values are set as <2 mg/L except those in August 2019. There are no Maximum Allowable Limits (MALs) laid down for marine waters in the environmental legislation.

Chemical oxygen demand: Overall, this variable shows a value of <5 mg/L, far below the established MAL of 50 mg/L.

Fecal coliforms: This variable increased during the second dredging period, but the data of August 2019 show an abnormal increase ascribed to an urban effluent performing discharges near the Naval school.

Arsenic: this metal increased during dredging maneuvers, although the overall averages were similar on dates with and without dredging maneuvers.

Cadmium: MALs were never exceeded.

Copper: This compound must be closely observed in the future since it is the most transported cargo from the Port Terminal. The presence of this metal has not increased as a result of dredging operations.

Chromium: Does not exceed the established MALs.

Iron: This compound regularly exceeds the national standard and is, alongside aluminum, the most abundant metal in the coast of Ecuador.

Mercury: The detection limit of the assessment is above the environmental legislation, hence the failure to abide by the established MALs.

Sediment quality. According to two-year monitoring data of seabed sediment quality gathered in line with the Monitoring and Tracking Plan (PMS) of the updated Environmental Management Plan in force associated with the dredging project, tests are carried out to determine the presence of heavy metals (arsenic, cadmium, copper, total chromium, iron, mercury, lead), total petroleum hydrocarbons (TPH) and pesticides (organochlorine, organophosphorus, organonitrogen and carbamate compounds).

The following list was compiled based on the recorded measurements in the project area of influence:

Total Petroleum Hydrocarbons (TPH): is always kept below the MALs, with the exception of the baseline monitoring procedure (performed in May 2017), where all monitored points are well above the MALs; and the monitoring procedure performed in May 2020 in point 7 (earth sedimentation basin), where a high parameter value was detected which pertains to waste discharges by illegal residents in the area.

Arsenic: is present on a regular basis in the monitored points, with values above the Canadian legislation in all points (from P1 to P7), and above the national legislation in two points; however, the same occurs regardless of whether dredging activities are performed or not. In this regard, it is worth noting that arsenic can be found in underground water inflows associated with natural geochemical processes, as a recurring element in marine and estuarine waters where continental water inflows and local variations in salinity, redox gradients and temperature can restrict the entry of arsenic from the mainland into the sea, and in drainages and leachates stemming from mining activities (Lillo, 2005); that it is a component in arsenical pesticides (Reigart & Roberts, 1999); and that there is evidence of its accumulation in Estero Santa Rosa seabed, as supported by the presence of bioaccumulated arsenic in the pustulose ark (*Anadara tuberculosa*) in Estero Huaylá, which exceeds the established allowable limits for consumption under the Australian and New Zealander legislations (Collaguazo, Ayala, & Machuca, 2017).

Copper: values above the Canadian and Ecuadorian legislations were reported at all points, with marked variations between maximum and minimum values informed throughout the year. Once again, this occurs regardless of whether dredging activities are performed or not. In this regard, studies on the assessment of the distribution of total and bioavailable heavy metal content, including copper, found that copper concentrations in Estero Santa Rosa fluctuated between 5.42 mg/kg and 39.17 mg/kg, with an average value of 21.85 mg/kg, of which

bioavailable copper makes up an average 9.5% of total copper (Senior, Valarezo, Yaguachi, & Marquez, 2015).

Mercury: Analysis show approved quantifiable limit values (<0.1) conforming to the MALs laid down in the local legislation, which are therefore deemed compliant with the standard since the exact concentration of quantifiable limit values is known to be below the reported value.

Cadmium, total chromium, lead and iron: show remarkable stability and are generally kept below the MALs laid down in the assessed legislations, with the exception of iron which lacks an established MAL.

Pesticides (organophosphorus, organonitrogen and carbamate compounds, and every other pesticide within these groups): their results appear as a constant value that is consistent with the approved quantifiable limit values; and which does not exceed the MALs, should there be any.

The above observations allow for concluding that these results may be associated with anthropic activities unrelated to dredging works (on the basis that the first dredging period took place by the end of March 2018), among which are aggregates and metal mining, and that they have an already reported impact on Estero Santa Rosa sediment quality.

5.3.2. Marine water quality in the sediment basin

Tributyltin (TBT): This parameter was monitored inside and outside of the offshore sediment basin in December 2020, and its corresponding results report is shown in Annex 5.a, Book IV of the Environmental and Social Impact Assessment (EIAS). This report informs values below the 0.2 mg/kg detection limit. With no local regulation laying down MALs for TBT, and taking as reference values those proposed by the National Institute for Coastal and Marine Management (RIKZ), which establishes the standard value for sediment quality at one MAL = 0.0007 mg/kg and a negligible value of 0.000007 mg/kg (for a standard sediment with 10% organic matter, or its equivalent 5% with organic carbon) (Stronkhorst & van Hattum, 2003), it is concluded that the TBT present in samples P1 and P2 exceed the reference value, although by a lower margin compared to other monitored locations at a national and global level.

The obtained results may be associated with the dredging and transportation of sediments from Puerto Bolívar pier aprons and maneuvering area, considering that traditional hull cleaning and painting works have been conducted in this port since last century's 1980s until 2017, year in which this activity was forbidden inside the Port Terminal.

5.3.3. Air quality and noise

Air quality and noise in the project construction area has been monitored for two years, often on a quarterly basis, through laboratories duly accredited by the Ecuadorian Accreditation Organization, pursuant to the provisions in the Environmental Management Plans.

The air quality monitoring point is located in the APPB piers (610951, 9639819), and the measured air quality parameters are as follows: Carbon monoxide (CO), Nitrogen Oxides (NOx), Nitrogen Dioxide (NO2), Sulfur Dioxide (SO2), Ozone (O3), Particulate Matter PM10

and PM2.5. During this time frame, all measured parameters ABIDE by the environmental legislation.

As for ambient noise, the monitoring points are located within the Port Terminal, namely: Point 1. Pier #1 (610941 , 9639369). Point 2. APPB Administrative Area (611136, 9639401) Point 3. Pier #5 (611014 , 9640135) Point 4. Puerto Bolívar Cabotage Pier (610892, 9639050). Results show that some points exceed the allowable limits for soil use (Ministerial Resolution 097-A, Annex 5: Maximum Noise Emission Levels and Methodology for measuring stationary sources and moving sources, Table 1: Maximum E levels).

5.3.4. Soil quality

In addition to accidental leaks of chemical substances and liquid waste, the main threat to soil quality is the inappropriate disposal of solid waste. The city of Machala lacks a comprehensive waste management system. The management performed is limited to street sweeping, collection and final disposal at a poorly planned and barely mechanized landfill. Waste is not sorted out at the source in a formal manner, and the only recycling solution is reached via private management plans from companies that see an opportunity for profiting from this activity.

The landfill of the city of Machala is located at the Ceibales area, 8 km southwest from the city. Its surface spans 20.20 hectares and has two macro-cells which are nearing the end of their useful lives. According to the local waste removal company, 116,000 tons of waste were collected in 2018, most of it being organic solid waste.

The main productive activities conducted in the city and province, besides transportation and healthcare facilities, produce hazardous waste (used oils, batteries, waste soaked in hazardous substances, anatomopathological waste, etc.), and special waste (electronic waste, tires, rubble) for which the city does not have any kind of management. As is the case with recyclable waste, companies with environmental regularization processes in place and which implement their Environmental Management Plan in a responsible manner carry out the storage and final disposal of hazardous waste within the framework of the legal regulation through environmental managers qualified by the Environmental Authority, while most producers dispose of this waste via sewerage systems, bodies of water, wastelands or areas surrounding the city, thereby producing a decline in environmental quality and threatening residents' health.

5.3.5. Land traffic

El Oro province road network spans a total of 3,036.70 kilometers, of which 389.88 kilometers belong to the state road network, and the remaining 2,646.82 kilometers to local roads.

The arterial road corridor consists of 99.43 kilometers pertaining to Troncal de la Costa roadway which passes through the province from the north to the southwest, thereby connecting it to the north with Cantón Ponce Enríquez in the Azuay province and to the southwest with Peru. The canton's main road network (1st order: more than 2 lanes), directly connects cantons Pasaje, Santa Rosa and Guabo with paved roads and at average distances of 12 km.

Avenida Bolívar Madero Vargas is the main access road to Puerto Bolívar urban parish and the Port Terminal. Urban buses and private vehicles also pass through it. In order to access this avenue, cargo trucks must take the perimeter access road to the urban area: 1) Avenida Circunvalación Sur is the most widely used, since it connects directly to the city's east access road (Vía Machala – Pasaje). Circunvalación Sur connects to the province's southern region (Vía Balosa – Santa Rosa). 2) Avenida Circunvalación Norte (at 2.7 km from the port entrance) is the most widely used, since it connects directly to the city's east access road (Vía Machala – Pasaje). Circunvalación Sur (at 2.3 km from the port entrance) connects to the province's southern region (Vía Balosa – Santa Rosa). Both ring roads have two lanes in each direction; nonetheless, the urban area is well established, therefore some sections may be considered urban roads, yet the traffic flows through them effortlessly.

With regard to land traffic as a result of port activities, the average number of cargo vehicles entering the Port Terminal is 2,500. Pursuant to Book V.D. on Maritime Traffic Assessment in the project EIAS, even though the data show heavier cargo vessel traffic, a tendency towards port traffic reduction in the Port Terminal is observed due to a rise in containerized cargo.

Between 2017 and 2020, the arrival of cargo in containers has increased from 4% to 49%. This means that the number of trucks of all sizes which previously carried banana boxes to the port is rapidly decreasing and being replaced by higher capacity containers hauled by a single truck, which has reduced consumption of fossil fuels, oils, etc., by a considerable amount, and this tendency continues insofar as the shift towards containerization does the same.

5.3.6. Maritime traffic

Estero Santa Rosa, between Estero Huaylá and the access canal to the Port Terminal, is undoubtedly the province's busiest maritime traffic area.

There are 3 entrance and exit points for vessels to and from Puerto Bolívar through Canal Santa Rosa:

Puerto Bolívar Port Terminal (YILPORTECU). The Port Terminal has 5 piers totaling 920 meters of mooring lines, which allow for mooring up to 5 merchant vessels at a time. Maritime traffic data pertaining to cargo vessels in Puerto Bolívar show an increase in the number of maneuvers as of 2017, yet the projections carried out by YILPORTECU point to stability and a tendency towards a reduction in trip frequency as a result of bulk cargo being replaced by containerized cargo and due to the arrival of higher capacity vessels.

Cabotage Pier. This pier Is located 0.2 km south of the Port Terminal and has 3 types of uses:

- Mooring and operational area for cooperatives involved in tourist maritime transport to the Jambelí resort.
- Mooring and operational area for the Navy.
- Mooring and operational area for tugboats that render services to the Port Terminal.

According to the information provided by tourist transport cooperatives, almost 500,000 tourists head for the nearby beaches in Jambelí each year. In terms of vessel trips, this

represents between 1,200 and 2,800 monthly trips, which are made by boats with a capacity for 40 passengers.

Estero Huaylá. Its mouth is located 1 km southeast of the Port Terminal. Throughout the years, tens of private piers have been built in this marsh, which serve as mooring points for over 1,200 vessels rendering transportation and supply services to shrimp and traditional fishing farms.

The Ecuadorian Navy catalogs 540 active vessels (less than 10 GRT[1]) in Puerto Bolívar, 43% of which are registered for fishing, 54% for cargo and passenger transport, whereas the remaining 3% pertains to sports, recreational and passenger vessels. Most of them are gathered in commercial and private piers located at Estero Huaylá, south of Puerto Bolívar.

However, a vessel count conducted on Sunday, 1 November 2020 from 6 a.m. Shows the following data:

Table 4. Vessel census in Estero Huaylá and the Cabotage Pier.

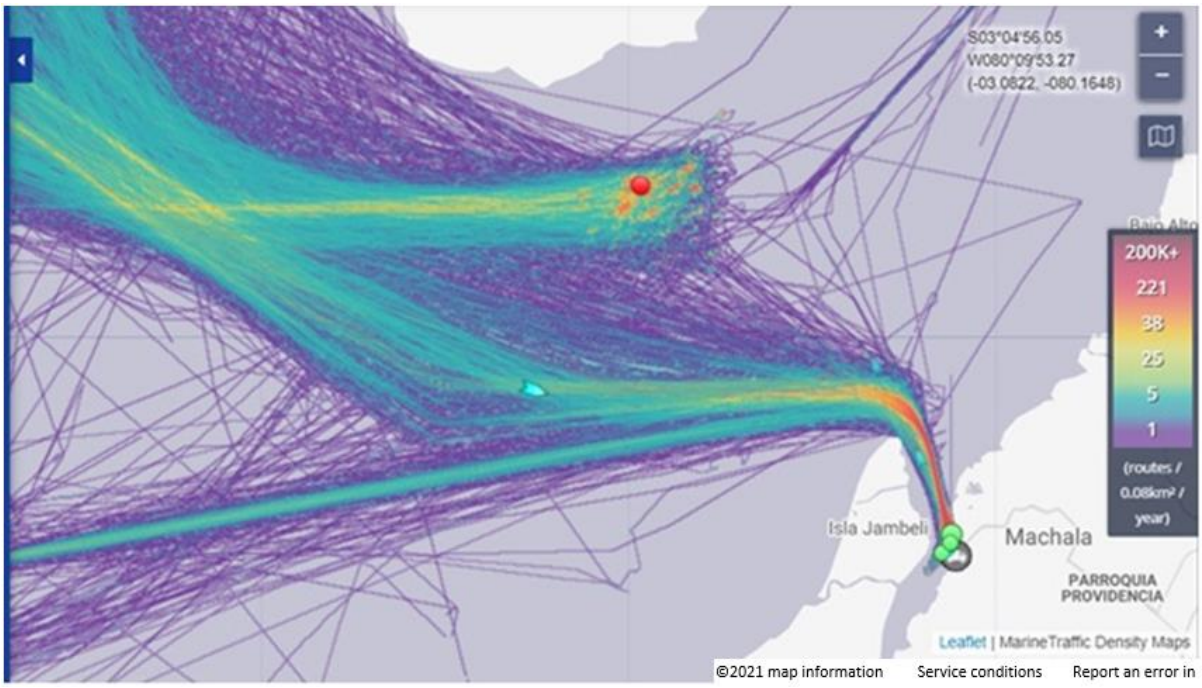
Type of vessel	Number
Fishing canoes	21
Wooden boat	30
Fiberglass boats	943
Industrial boats	84
Shrimp fishing feluccas	109
Barges	20
Logistic vessels	13
TOTAL	**1,220**

Prepared by: Ecosambito, 2020

Figure 1Figure 5 [*sic*] shows vessel traffic density recorded in the area of influence during the 2019 period retrieved from the freely available database www.marinetraffic.com, without distinction in relation to vessel type.

[1] Gross registered tonnage, total volume of a vessel intended and used for the carriage of passengers and goods.

Figure 5. Vessel traffic density in Canal de Jambelí and Estero Santa Rosa in 2019



Retrieved from www.marinetraffic.com

5.3.7. Marine coastal biodiversity

During the 2018-2020 period, qualitative and quantitative sampling methods were employed within the project area of direct influence to confirm a total of 191 phytoplanktonic species, 54 types of zooplankters larger than 300 micrometers, 59 zooplankters larger than 500 micrometers, 79 soft-bottom subtidal benthic species, 69 infauna species from sandy and muddy beaches; in addition, 72 fish species were captured and the presence of 12 marine beings protected by international agreements was observed; these pertain to the only aquatic beings categorized as vulnerable by IUCN's REDList.

Although no specific bird tracking endeavors were conducted, bibliographic reports from previous studies show 104 recorded species (Francisco Sornoza, 2013); taking into consideration both mangroves and areas near the coast of Isla Santa Clara in 2013; moreover, in the vicinity of Puerto Bolívar project, specifically in mangroves, the study of Orihuela - Torres et al., 2016, identified the presence of 50 bird species.

Table 5 shows in detail the main species richness estimation groups in the area of influence of Puerto Bolívar Expansion Project Stage 1.

There is a significant relation between biodiversity and its exploitation by fisheries and tourism in marine coastal areas; to illustrate this, take rockfill structures built in front of Playa Jambelí as an example, which have not only turned the latter into a calm water area suitable for recreational activities aboard smaller rowing vessels, but also gathered bigger fish, thus becoming a perfect location for sport fishing, as shown in the photograph below.

Photographic record 1 Snook Centropomus sp caught using the pole-and-line fishing method in Playa Jambelí artificial rocky outcrops.

Table 5. Estimated species richness in the area of influence

Phytoplankton	**Zooplankton larger than 300 micrometers**	**Zooplankton larger than 500**	**Benthic community subtidal**	**Beach infauna**	**Ichthyofauna**	**Protected marine beings**
Bacillariophyta 123 species	*Crustacea* 22 types	Crustaceans 21 types	Crustaceans 12 species	Crustaceans 15 species	Fish 72 species	Marine mammals 4 species
Miozoa 43 species	*Chaetognata* 3 types	*Chaetognata* 3 types	*Scaphopoda* 1 species	*Bivalvia* 23 species		Reptiles 1 species
Protozoa 14 species	*Polychaeta* 7 types	*Polychaeta* 6 types	*Bivalvia* 18 species	Gastropods 7 species		Fish 7 species
Cyanophyta 10 species	*Larvacea* 1 type	*Larvacea* 1 type	Gastropods 12 species	*Echinodermata* 4 species		
Charophyta 1 species	Urochordata 4 types	*Urochordata* 3 types	*Echinodermata* 3 species	*Polychaeta* 12 species		
	Cnidaria 5 types	*Ctenophora* 1 type	*Cnidaria* 1 species	*Cnidaria* 1 species		
	Mollusca 3 types	*Cnidaria* 6 types	*Nemertea* 1 species	*Brachiopoda* 1 species		
	Echinodermata 1 type	*Mollusca* 3 types	*Polychaeta* 28 species	*Platyhelminthes* 1 species		
	Fish 8 types	*Echinodermata* 3 types	Sipunculida 1 species	*Nemertea* 1 species		
		Fish 12 types	*Priapulida* 1 species	Sipunculida 1 species		
			Platyhelminthes 1 species			
191	54	59	79	66	72	12

Prepared by: Ecosambito, 2020

Mangrove. As of 2019, El Oro province has 19,318.39 ha of mangroves, 15,636 of which have been handed over in the form of Mangrove Sustainable Use and Custody Agreements

(AUSCM) to 23 associations (UTPL, 2019), thus covering 81% of the existing mangroves in the province.

The mangrove area coverage estimate made through GIS systems in November 2020 was 7,611.80 ha in the area of direct influence. According to the land zoning and development plan document of Cantón Machala in its 2018 update, in 2014 there were 4,011.44 ha of mangroves in this canton.

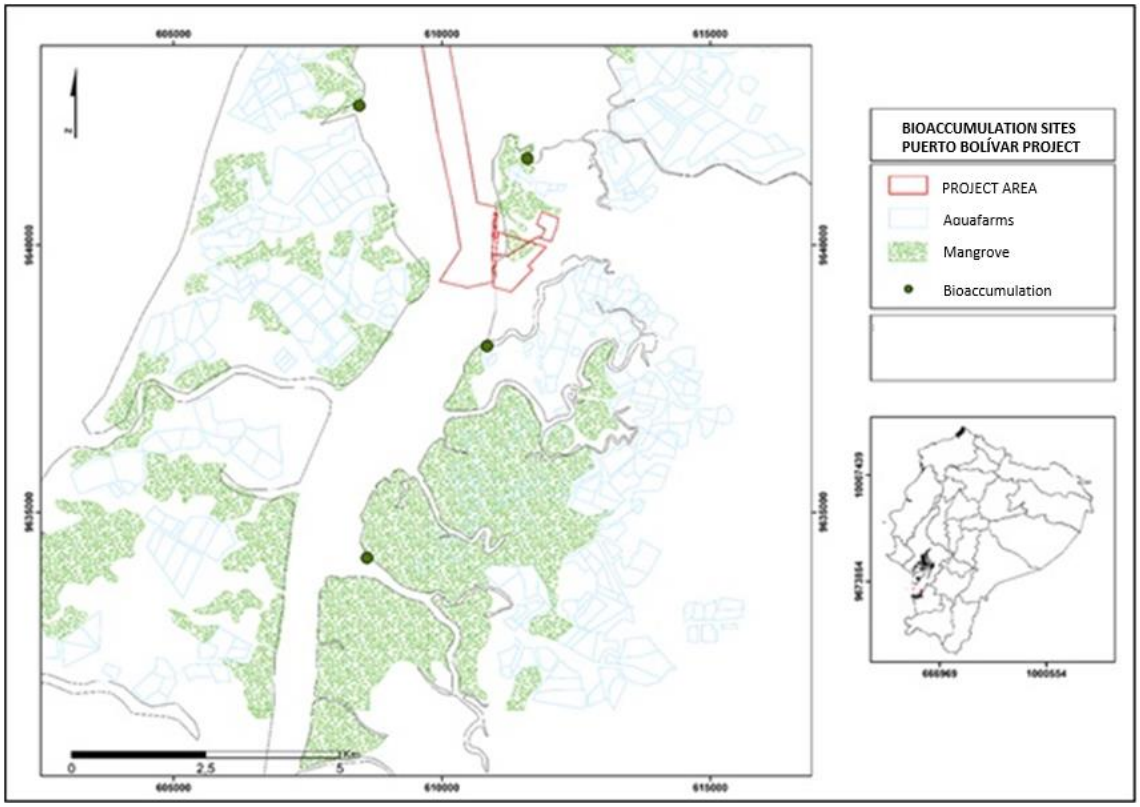
The legal instrument in force by which mangrove areas are handed over to ancient or traditional communities of users for their sustainable exploitation is referred to as Mangrove Sustainable Use and Custody Agreement, or AUSCM, whereby the government grants a 10-year co-management license once the beneficiary group approves a management plan which will have periodic assessments. There are 3 AUSCM near Puerto Bolívar Expansion Project Stage 1, which have maintained productive activities from 2018 to 2020, particularly in the extraction of shells and crabs at the georeferenced regions described in the Environmental Services chapter. The most productive USCM with regard to mangrove fishery resources is referred to as “Vikingos de Mar”, with mangroves located in the marsh at the entrance to the Jambelí resort.

The predominant species which populate these forests are *Rhizophora mangle*, *R. racemosa*, *R. x harrisonii, Laguncularia racemosa var. racemosa*, *L. racemosa var. glabriflora* and *Avicennia germinans* (Cornejo, 2014).

There are documents that emphasize bird diversity in El Oro mangroves, particularly in the area of direct influence, which are described in the Biodiversity chapter.

Chemical quality assessments in mangrove regions within the area of direct influence are rare; for that reason, in November 2020, 4 samples were collected in 4 mangrove areas, which are shown in Figure 6.

Figure 6 Shell and sediment sampling sites locations in mangroves, November 2020



Prepared by: Ecosambito, 2020

The samples consisted of pustulose ark *Anadara tuberculosa* specimens of two size ranges, collected by 4 local gatherers who extracted shells in each site for an hour. Also, sediment samples of the surface's first 3 cm were gathered in shell-collecting areas (mangrove sediments), as well as in the subtidal surface layer at the site where sample collectors disembarked. The samples were taken to a duly accredited laboratory that determined their contents were 20 metals and metalloids, which enabled the analysis of 8 shell samples (two size ranges per site) and 8 sediment samples, so as to monitor the changes in metal and metalloid contents between the sampling sites; 2 sampling sites were located at less than 2 km from Puerto Bolivar port complex, and 2 stations at a distance from the complex and the urban influence.

The results and assessments of said study are attached to this report.

5.3.8. Community health and safety

Records show that Cantón Machala has 245,972 residents and the number of beds for their healthcare is 693, i.e. 25.9 beds per every 10,000 residents. In line with that, Cantón Machala has a shortage of 4.1 beds per every 10,000 residents in order to provide for its entire population. There are 3 healthcare facilities within Puerto Bolívar Parish.

Diabetes and hypertension have constituted the main causes of death at the provincial and regional level in the last 20 years.

As for morbidity, the main causes for seeking medical attention in the parish are those related to urinary tract infections, acute rhinopharyngitis (common cold), intestinal parasite infection without further specifications, unspecified acute pharyngitis, cervicitis, diarrhea and gastroenteritis of presumably infectious nature, streptococcal tonsillitis, among others. The leading health problem in 2020 is the COVID-19 pandemic, a respiratory disease caused by the SARS-CoV2 virus. Its global dissemination has had a dramatic impact on morbidity, mortality and health services ability to respond accordingly.

5.3.9. Economy

This Environmental Component groups socio-environmental components that are generally influenced in a positive way by the project, such as commerce and services supply and demand.

The region's economy is based on the farming and export of shrimp and banana, the production of which takes place at the peri-urban and rural area. The Port Terminal is a key element that supports and drives this production – exploitation dynamics, and invigorates the province's economy.

According to the Central Bank of Ecuador, El Oro province constitutes just over 3% of the national value-added production, thus it cannot be regarded as an industrial development area.

The primary sector in El Oro province constitutes, as of 2014, 26.6% of the entire province's economy (with the exception of the oil industry). On the other hand, services are established in the most dynamic economic sector, reaching 63.1% of the Gross Value Added. Therefore, the sum of the primary and service sectors' GVA adds up to a value of 89.7% of El Oro's GVA, thereby evidencing that these sectors produce an immense added value in the province, whereas the manufacturing industry, with barely 4.7% of the GVA, is of secondary importance (Capa et al., 2018).

5.3.10. Tourism

Some communities and social groups benefit from tourism due to Canal Santa Rosa and Archipiélago de Jambelí landscape resources.

Puerto Bolívar promenade is a traditional recreational area for Machala citizens, who visit it not only for its landscape quality but also for its cuisine.

Jambelí and El Faro beaches are widely visited throughout the year by locals and tourists alike, and in particular by residents of provinces in the country's southern mountainous region.

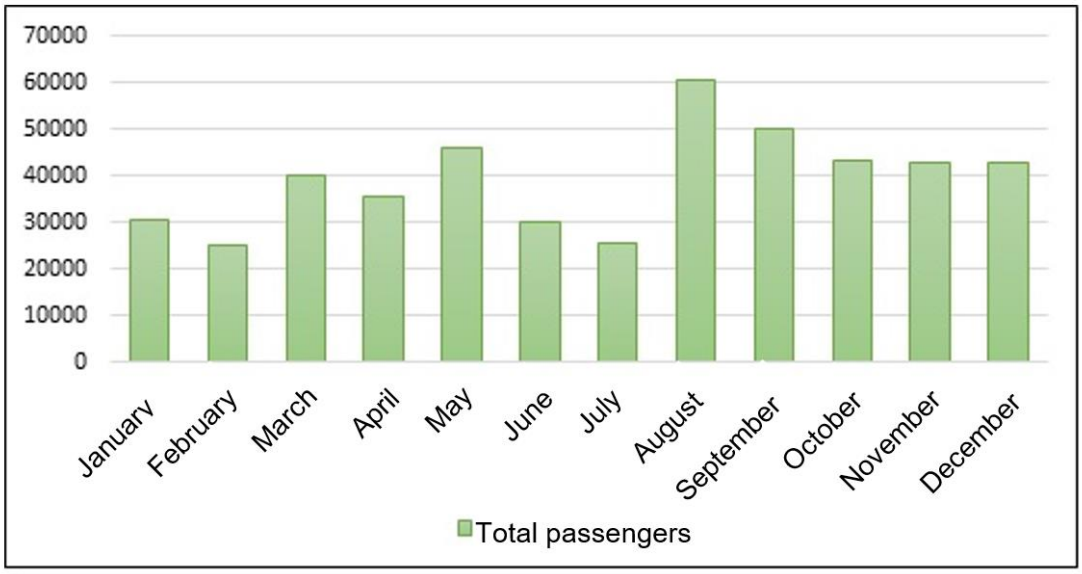
A significant flow of visitors and tourists is observed from the Cabotage Pier to Jambelí, El Faro and La Playita resorts, where the Ecuadorian government has made investments in tourism protection and promotion (the most recent ones being rockfill walls in Jambelí and a floating pier in La Playita), and which have enabled an increase in the area's biodiversity and the development of recreational activities such as line-caught fishing of big fish.

It is worth noting that both the access mangroves to Playa Jambelí and the surroundings of La Playita and El Faro are part of the licensed areas mentioned in the above paragraph.

According to the Port Traffic Assessment conducted for this project, there is a large number of tourists circulating from the Cabotage Pier to the Isla Jambelí beach.

Due to the anomalies caused by the COVID-19 pandemic, data from 2019 were collected which were gathered by leaders of maritime transport companies who provided this service. These data reveal that around 470,000 people travel to Isla Jambelí each year. For this reason, there are approximately 40 vessels devoted to these tours.

Figure 7. Passengers traveling to Playa Jambelí.



Prepared by: Ecosambito, 2020

International cruise ships have reached the Port Terminal, for instance, the *Silver Explorer* in 2016 carrying 130 passengers, and the Seabourn Quest in 2019 with 400 tourists on board, who took part in tours around the different tourist attractions offered by El Oro province, such as the Puyando Petrified Forest and Arenillas and Buenaventura ecological reserves. This activity, which is halted due to the pandemic, is expected to resume and increase in the coming years.

5.3.11. Cultural heritage

Due to ethnohistoric references and archaeological investigations in the south coast of Ecuador, the remains of pre-Hispanic settlements have been reported which date back from the Formative Period (Valdivia culture), to the Regional Development Period (Jambelí) and the Integration Period (Milagro – Quevedo). Towards the north and east of Puerto Bolívar Port Terminal, vestiges of late pre-Hispanic settlements can still be seen, although most of them have been affected and destroyed by modern human communities, formal and informal settlements, civil infrastructure works in addition to crops, generally combined with the natural processes they have undergone through time (cultural and natural transformation processes; Schiffer 1987).

In the vicinity of the assessed area (at a distance of approximately 6 km) the following archaeological sites have been reported:

Table 6 Archaeological sites

Site	Type	Culture
Estero Chivería 2	Residential	Jambelí
Estero Chivería 1	Residential	Jambelí
La Puntilla	Residential	Jambelí
La Primavera	Residential	Jambelí
Los Vergales	Residential	Jambelí

Prepared by: Ecosambito, 2020

5.3.12. Fisheries

Fisheries associated with the Project AID are traditional for the most part, and involve four main modalities: The traditional pedestrian fishing (PAP) focused on the collection of marine invertebrates (*bivalvia* and crustaceans) and having an uninterrupted activity in Estero Santa Rosa beaches and mangroves; the still passive arts fishing (PAF) which is regulated and focused on smaller crustaceans and fish; non-motorized traditional coastal fishing that is clearly decreasing and being performed exclusively in smaller bodies of water with mangrove presence; and lastly the motorized traditional coastal fishing in which most fishers who live in the vicinity of Puerto Bolívar are involved and that is focused in the extraction of crustaceans and fish.

The estimated number of fishers aboard vessels was updated at Puerto Bolívar in November 2020, and it maintains previous estimations conducted in 2013, the assumption being that they operate in the area of direct influence of Puerto Bolivar Expansion Project Stage 1, and it is predicted that there will be around 1,250 smaller vessels which will require the work of 3,000 fishermen.

Table 7. Traditional fishing fleet and seamen in the area of influence of Puerto Bolívar Expansion Project

Cove	Estimated vessel number			2013* estimate	2013** National Fishing Institute (INP) estimate	Current assessment
	Fishing canoes (1.5 fishermen)	Wooden boat (2 fishermen)	Fiberglass boats (2.5 fishermen)			
Puerto Bolívar	17	28	943	2,820*	1,825	2,439
*La Puntilla***	*25***	*15***	*9***	*101**	*100*	*101**
*Bajo Alto***	*50***	*120***	*5***	-	*414***	*414***
Tendales	*20***	*14***		-	*120***	*120***
Playa Jambelí	-	-	-	*50**	-	*50**

Total	17	28	963	2,870	1,825	2,489

Prepared by: Ecosambito, 2020

Table 7 only includes seamen aboard vessels; therefore, in order to make an accurate estimate of users of fishery resources, the estimated number of shellfish gatherers (PAP) operating in mangroves and beaches near Puerto Bolívar needs to be added as the author considers that said number would fluctuate between 150 and 200 shellfish gatherers operating on a daily basis.

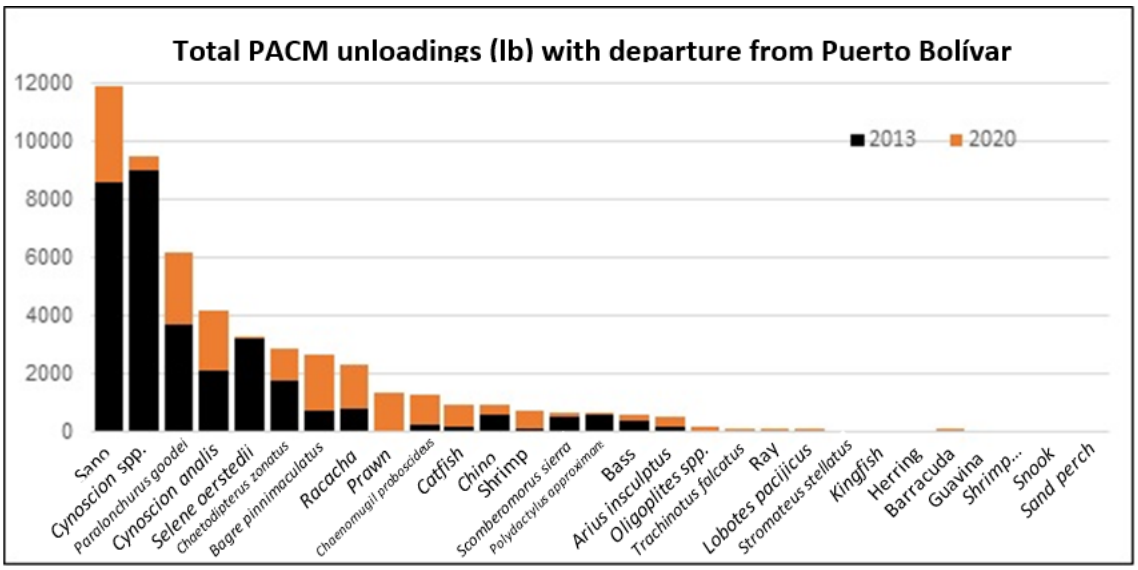
PACM include at least 60 resources captured in the Project area of direct influence, being net capture the most common capture practice in the area, whose descriptions are shown in table 8 and figure 8 respectively, and where 250 fishing records analyzed during November 2020 are compiled.

Table 8. Fishing variables associated with the main arts employed in the project area of influence

Variable/fishing art	Mono 2 ¾"	Mono 3"	Mono 4"	Mono 4.5"
No. of records	145	52	23	30
Time outside the port	9.96± 1.55	10.14± 1.70	10.54± 3.32	10.78± 1.90
Average capture (lb/fishing trip)	71.37± 58.52	87.22± 59.28	84.81± 77.63	70.39± 55.11
CPUE (lb/fishing time)	19.18± 18.86	19.90± 15.45	21.46± 28.09	12.95± 9.02
Profit (Us$/vessel/fishing trip)	30.57± 20.46	66.21± 64.54	44.78± 30.74	63.42± 60.60

Prepared by: Ecosambito, 2020

Figure 8 Main fishery resources exploited in the area if influence of Puerto Bolívar project



Prepared by: Ecosambito, 2020

Photographic record 2: "Bowling" capture type, 8 meshes sized 2"3/4, 20´ away from Puerto Bolívar

6. Other activities and external factors

6.1. External natural factors

Several external factors may cause "natural" damages to the Environmental Components, of which the main identified external factor that will alter the coastal border of the Project areas of direct and indirect influence is sea level rise or SLR; this is addressed in further detail in the Critical Habitats document.

According to the studies of Leonor Vera (2004) from 1970 to 2002, sea level would have increased by 16 cm in Puerto Bolívar. Since 2012, this process has forced the Ecuadorian government to invest in the construction of rockfill retaining walls at the most highly-trafficked resorts such as Playa Jambelí and Bajo Alto; moreover, this is evidenced by the significant reinforcement of coastal structures, mainly coastal shrimp farms located in mangrove internal bodies of water.

Other natural phenomena that could potentially affect fisheries is the occurrence of El Niño and La Niña events, the former being associated with a reduction in ocean productivity, thereby reducing fisheries productivity while increasing the occurrence of HABs[2] that have been recorded in previous years in the vicinity of the dredged sediment disposal basin, as a bloom of *Noctiluca scintillans in 2018, when no dredging maneuvers were taking place, although it was mistakenly related to these maneuvers or to a far-reaching salp bloom recorded in the vicinity of Isla Santa Clara in 2015.* These events depend on harsher oceanographic conditions in open waters, yet are influenced in inner waters by other inland undertakings, and in the mangroves mentioned hereafter.

[2] Harmful Algal Blooms

6.2. Identification of relevant nearby undertakings

6.2.1. Preexisting undertakings

Identification of past activities allows for determining the conditions of the environmental components in the project area, the types of damages suffered and their duration, and whether these damages are still being inflicted.

The three undertakings described below are interrelated: Campo Amistad, Termogas Machala power plant, and Bajo Alto natural gas liquefaction plant were planned and built in order to harness the natural gas in the Gulf of Guayaquil during a period known as a shift in the productive infrastructure of Ecuador, which is still taking place. They are described below:

Campo Amistad (Block 6 Petro Ecuador). Within the marine environment, the single coexisting undertaking near Puerto Bolívar area of influence is the flow of natural gas from Campo Amistad to Bajo Alto town, where it is supplied by Termogas Machala combined cycle power plant and the Natural Gas Liquefaction Plant run by Petroecuador. Even though the drilling record dates back to 1970, the commencement of operations took place in 2003. It consists of 17 drilled wells, 4 production wells, 70 km of 12-inch gas pipelines, a dehydration plant (Bajo Alto) and a Logistics Base (pier). In addition, it has campaigns adding up to 196 km2 of 3D seismic and 1,510 km2 of 2D seismic (Block 6). By 2018, gas production reached 38 MMSCFD (million standard cubic feet per day). Environmental permit No. 005 dated 13 January 2011 and its supplementary assessments allow for drilling 15 additional wells.

Termogas Machala Power Plant. It is located at Bajo Alto town in Cantón Tendales, El Oro province, north of the project area of influence. This is a combined cycle power plant operating with natural gas from offshore platforms in the Gulf of Guayaquil. It is currently being run by CELEC EP and has a power of 250 MW divided into two unit groups, 130 MW into two 6FA gas units, which commenced their operations by the end of 2002, and 120 MW into 6 units 6FA gas units, which commenced their operations in early 2012, supplying the resulting electricity to the National Interconnected System.

Bajo Alto Natural Gas Liquefaction Plant. It is run by Petroecuador EP, is located at the Bajo Alto town and its goal is to liquefy gas from Campo Amistad in the Gulf of Guayaquil. It processes around 100 metric tons of Natural Gas per day through a cryogenic process which reduces Liquefied Natural Gas (LNG) temperature until 160 degrees below zero, thereby producing a shift from its gas state to its liquid state.

Approximately 85% of this production is supplied to the ceramic industry of the Azuay province, and to more than 3,000 residents of the communities of Bajo Alto, Barbones, Tillales, Tendales and adjacent areas to Cantón El Guabo, which benefit from 63,000 cubic feet of gas per day for domestic consumption.

6.2.2. Leading economic activities in El Oro province

This section identifies the economic activities in the province, each of which consists of tens of private undertakings. Banana and shrimp farming activities not only create several local jobs, but are also a direct source of foreign exchange income to the country.

The official data in relation to these economic activities is compiled by the Central Bank of Ecuador. Although the relevant data pertains to a recent period, these activities have been carried out for several decades, as is the case with banana and shrimp farming. The latter's boom happened around the 1990s, when large natural areas were turned into shrimp farming ponds.

This section presents the historical development and impact of the main economic activities in the province, so as to show their relevance in the current environmental state.

Table 9. Undertakings and activities in El Oro province

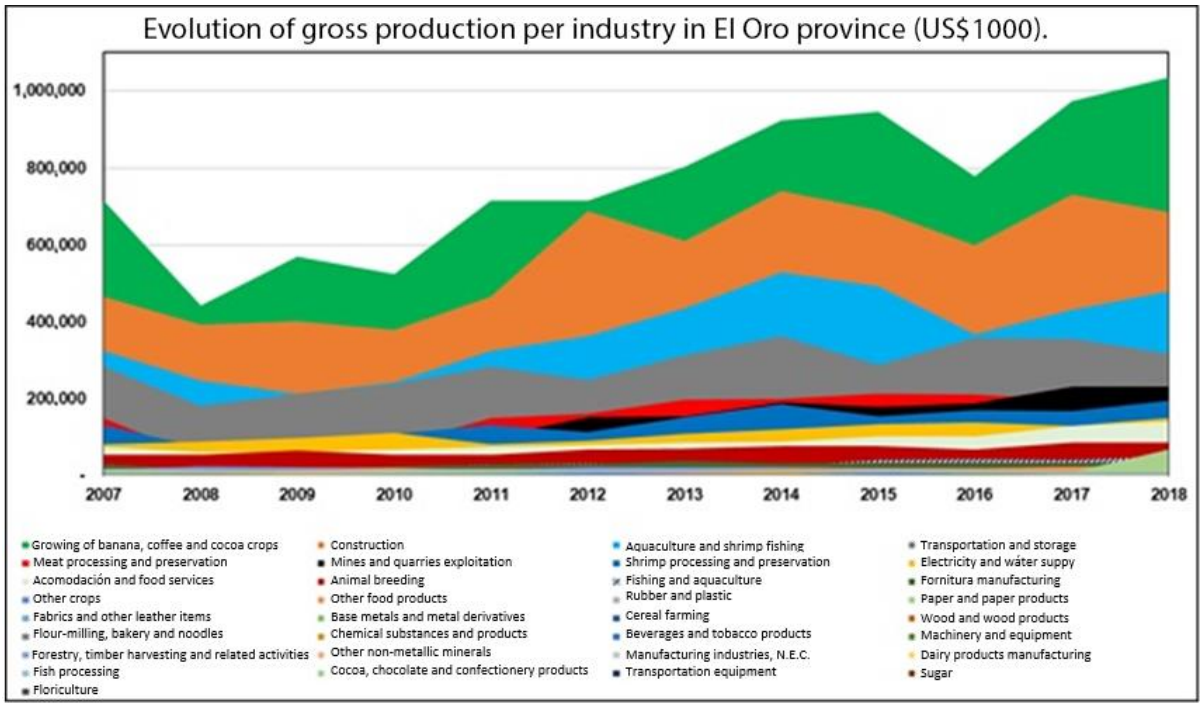
Gross Value Added (GVA) (Thousands of dollars)	
Activities	**Total**
Growing of banana, coffee and cocoa crops	768,150
Wholesale and retail trade, repair of motor vehicles and motorcycles	536,112
Construction	408,806
Education	232,172
Social and healthcare services	185,026
Transportation and storage	168,596
Shrimp aquaculture and fishery	157,873
Mines and quarries exploitation	148,203
Professional, technical and administrative activities	130,936
Public administration, defense, mandatory social security plans	129,329
Leisure, recreation and other service activities	109,856
Financial services activities	107,506
Real estate services	81,997
Accommodation and food services	81,214
Meat processing and preservation	70,968
Shrimp processing and preservation	69,815
Post and communications	62,784
Electricity and water supply	54,118
Paper and paper products manufacturing	27,139
Fishery and aquaculture (with the exception of shrimp)	26,084
Animal breeding	21,514
Other crops	17,665
Private homes with domestic service	16,263
Furniture manufacturing	13,346
Rubber and plastic products manufacturing	7,108
Other food products manufacturing	6,197
Cereal farming	4,824
Flour-milling products, bakery products and noodles manufacturing	3,596
Fabrics, clothing, leather and leather items manufacturing	2,823
Forestry, timber harvesting and related activities	2,481
Chemical substances and products manufacturing	2,469
Base metals and metal derivatives manufacturing	2,139
Wood and wood products manufacturing	1,712
Machinery and equipment manufacturing	1,529
Beverages and tobacco products manufacturing	1,322
Other non-metallic mineral products manufacturing	985

Gross Value Added (GVA) (Thousands of dollars)	
Activities	**Total**
Manufacturing industries, N.E.C.	766
Insurance plan financing, with the exception of social security	431
Dairy products manufacturing	392
Transportation equipment manufacturing	107
Cocoa, chocolate and confectionery products manufacturing	53
Floriculture	23
Sugar manufacturing	3
Oil and natural gas extraction and related service activities	0
Manufacturing of plant and animal derived oils and fats	0
Processing and preservation of fish and other aquatic products	0
Manufacturing of oil refinery products and other refinery products	0
Grand total	**3,664,429**

Source: www.bce.fin.ec
Prepared by: Ecosambito, 2020

The first step in order to identify relevant undertakings was to assess only the higher volume productive activities (excluding services) since those are the ones that produce damages to the environment. Subsequently, the development of these activities was analyzed in search of incremental tendencies, which is why their economic movement for the 2007-2018 period was illustrated.

Figure 9. Development of gross industrial production in El Oro province



Source: www.bce.fin.ec
Prepared by: Ecosambito, 2020

Figure 9 shows the relevance of 6 main undertakings in relation to money amounts and incremental tendencies in production during the assessed period. The following are the most relevant undertakings in El Oro province within the Project area of influence:

1. Continuous growing of banana, cocoa and coffee crops.
2. Construction
3. Shrimp aquaculture and fishery,
4. Transportation and storage,
5. Mines and quarries exploitation,
6. Meat and shrimp processing and transformation

Below are relevant data regarding the state of these activities after analyzing the characteristics and impacts related to them using the bibliographic review methodology.

Continuous growing of banana, cocoa and coffee crops

Continuous crops cover almost 50% of Cantón Machala surface (Figure 10), 35% of which are used for banana farming.

Figure 10 Surface by soil use in Cantón Machala.

Hectares by type of farming within canton Machala. Year 2014

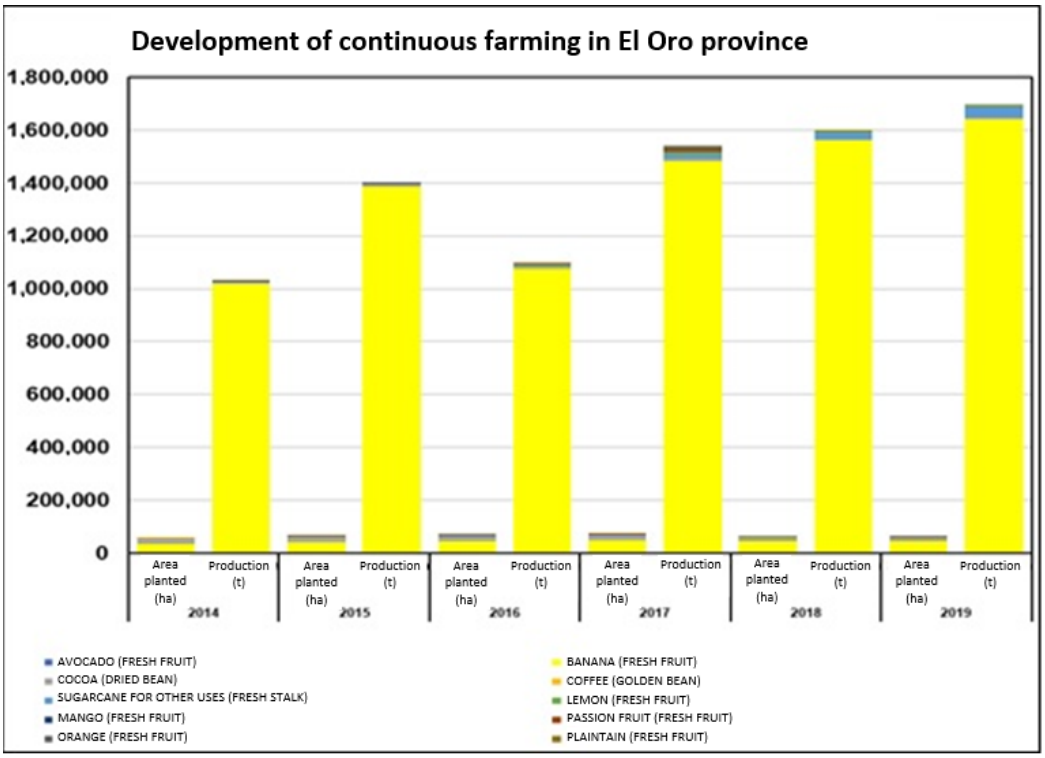
Soil usage	Area (Ha)	Territory %
MANGROVE	4,011.44	10.76
RICE	64.33	0.17
BANANA	13,224.18	35.48
COCOA	245.73	0.66
SHRIMP FARMS	8,236.66	22.10
ANNUAL FARMING	0.15	0.00
CONTINUOUS FARMING	96.63	0.26
SEMI-CONTINUOUS FARMING	905.24	2.43
FRUIT TREES	2,774.74	7.44
MOSAIC FARMING SYSTEM	417.10	1.12
PASTURELANDS	219.31	0.59
GRASSLANDS	1,505.41	4.04
BODIES OF WATER	1,778.74	4.77
URBAN AREAS	3,795.58	1.18
TOTAL	**37,275.23**	**100.00**

Source: POT GAD Machala, 2018
Prepared by: Ecosambito, 2020.

El Oro province has a surface of 579,185 ha, 37.94% of which is regarded as coast, whereas the remaining percentage pertains to mountainous regions. Banana, whose crops are found in flat and low regions, cover 45,549 ha, 21% of the province's flat-level regions.

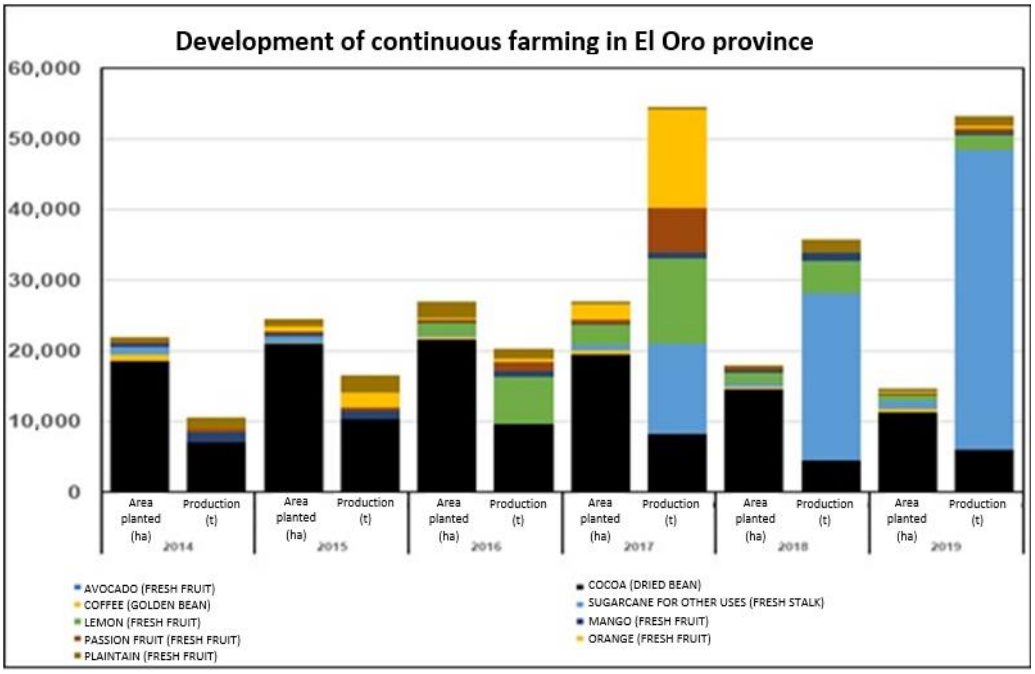
The development of cultivated surface, as described in the ESPAC database for these crops, shows that banana occupies the largest portion of the province's cultivable soil, which also increased to 25.99% in 2019. Other crops, such as cocoa and coffee, are subject to considerable fluctuations each year, perhaps due to the instability of international prices. By 2019, cocoa was the second most-grown continuous crop in terms of cultivated surface. The continuous crop with the third most extensive surface use is sugarcane, which in 2019 registered 1,145 ha.

Figure 11. Development of planted surface and continuous crop production in El Oro



Source: www.bce.fin.ec, Prepared by: Ecosambito, 2020

Figure 12. Development of planted surface and continuous crop production in El Oro with the exception of banana



Source: www.bce.fin.ec
Prepared by: Ecosambito, 2020

The environmental footprint of the Ecuadorian banana, on the basis of carbon footprint (CF), water footprint (WF) and profit distribution throughout its value chain, was estimated by Roibas et al. in 2015, who determined that in conventional farms CF would be 302 g CO_2 / banana kg, whereas in organic farms it would be 249 g CO_2 / banana kg, thus concluding that the reason for such variation was the large quantity of nitrogen fertilizers used in the first ones. This rise in nitrogen levels is associated with an increase in its water footprint: 158 l / kg in traditional crops against 58 l / kg in organic ones.

The environmental impacts of banana crops, as per bibliographical sources (Russo y Hernández,1995), are as follows:

- Intensive use of agricultural chemicals, particularly of pesticides. Banana plants are affected by over 200 insect pests that cause direct harm to the plant or act as disease vectors (Purseglove, 1972). Black sigatoka, which is caused by the fungus of the *Mycosphaerella fijiensis* leave, constitutes the major limitation to banana world production. This disease illustrates one of the issues large monoculture plantations with scarce genetic diversity face: all plants are very much alike, hence prone to catching a disease or a common pest. Pesticides are persistent organic pollutants or contaminants, they bioaccumulate and move from one trophic level to another affecting multiple land and aquatic species. The indiscriminate use of pesticides in order to control these pests has also decreased the number of predatory insects and parasites, and has led to pest outbreaks of insects which were previously of minor importance to banana plantations (Stephens, 1984).
- Surface and subsurface water pollution by pesticides used in crops may occur: i. When using rivers to dispose of waste contaminated with pesticide residues. When washing equipment used in the application of these products directly at water sources or in close proximity to them. iii. Due to runoff. iv. By percolation. v. By the action of drift after aerial application procedures are performed (García, 1997).
- Due to poor management of plastic and degradable waste
- Due to deforestation and erosion. Large areas of tropical ecosystems were turned into crops, among which banana is one the main sources of changes during the last century.
- Intoxication by herbicides. A peculiar case is that of the Paraquat herbicide which damages the respiratory system regardless of the exposure pathway. In relation to the period lasting from January 2013 to December 2014, it was concluded that this herbicide was responsible for the highest number of deaths by pesticides in Ecuador: the monitoring of 216 intoxicated patients produced a case survival rate of 34.7%, as per the Toxicological information and counseling center of the Ecuadorian Public Health Ministry (Villalba and Zalazar, 2015).
- The pesticide load used in banana crops is proportionally higher than in other crops such as coffee and cocoa due to a greater number of international requisites in relation to origin quality, which requires crops free of pesticides during their production cycle.

There is keen interest from the industry to shift to organic production, which is also more profitable. However, organic crops would be more prone to catching black sigatoka. Organic crop yields compared with conventional ones, as per Jiménez et al (2007), had a 40% lower yield over "inorganic" crops, a result that shows banana crops' heavy dependence on pesticides.

Construction

The second largest undertaking in El Oro province shows few published records in relation to its impacts with difficult traceability, except for the development of larger "formal" works carried out by construction companies; in spite of this, there is a predominance of informal constructions carried out without construction permits at the lower middle level of the Machala-Puerto Bolívar conurbation and its rural parishes within the area of influence.

On the basis of the Land Zoning and Development Plan (PDOT) of the Decentralized Local Government of Machala in its 2018 update, it was determined that the Machala Puerto Bolívar conurbation, bearing a population of 252,739, had occupied an estimated 37,275 ha by the year 2014 in Cantón Machala, and the projections for 2020 indicate 289,141 inhabitants.

Most impacts in this sector relate to the poorly-planned housing development and the lack of services; as a result, sewage (waste) water discharges of the developing Machala Puerto Bolívar conurbation are directed to natural waterways without being treated. Other related impacts include:

- Decline in the quality of water bodies. An assessment of the quality of Estero El Macho waters (López Apolo, 2015), which flow throughout the northern border of Machala and receive other waters from banana farms and waste urban waters and combine them with coastal ones, revealed concentrations exceeding the MALs for manganese, with maximum values of 1.72 mg/L; Iron, with value of 0,45mg/L; sulfurs, with a maximum value of 2,57 mg/L; and COD, with a maximum value of 850 mg/L; BOD, with a maximum value of 443 mg/L; furthermore, 9 out of 10 dissolved oxygen readings were below 2,8 mgO_2/L; and lastly, there was a rise in organic and total nitrogen downstream.
- Constructions in the coastal border would produce impacts associated with habitat transformation, being the latter one of the main agents involved in the reduction of mangrove-covered regions which have been turned into populated areas after their logging and filling.

Shrimp aquaculture

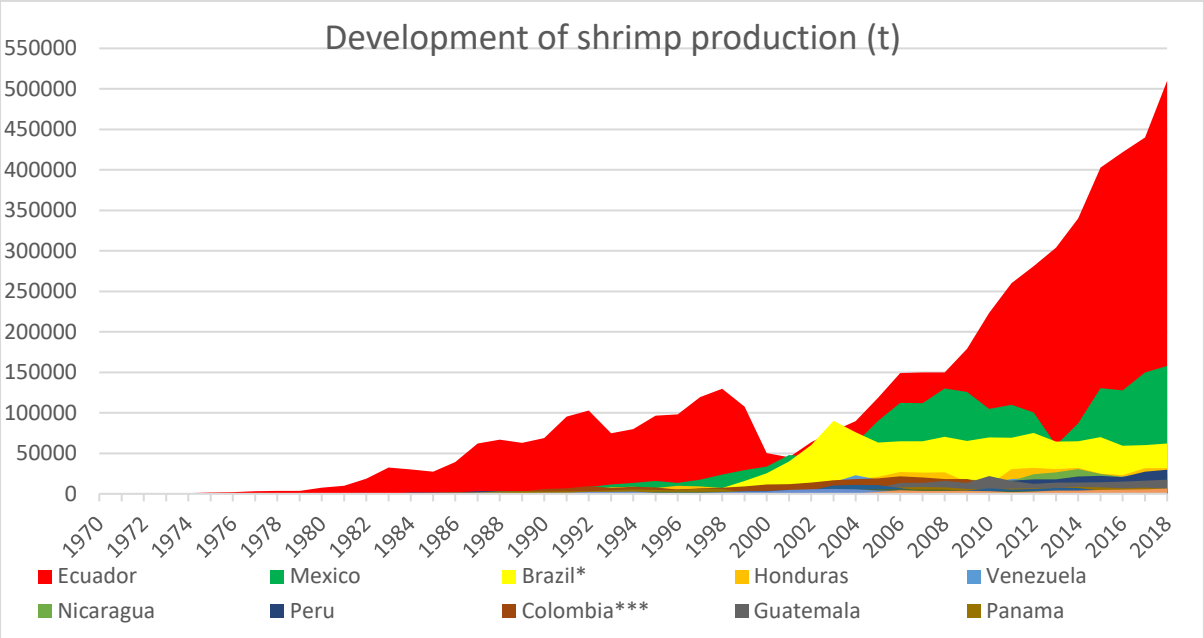
According to the Ministry of Aquaculture and Fisheries, Deputy Ministry of Aquaculture[3], by the year 2017, shrimp cultivation involved 996 production centers, which totaled 41,637.12 ha in El Oro province, i.e. 19.32% of the national surface for shrimp farms from that period, which totaled 215,421 ha.

[3] Official letter N° MAP-SUBACUA-2018-0392-O addressed to the Aquaculture National Chamber

Of these 41,637.12 ha of shrimp parcels, 652 of them were located in beach and bay areas, that is, close to the coastal border which was originally teeming with mangroves, totaling 20,855.89 ha, and 344 parcels were located in highlands, totaling 20,751.23 ha.

Figure 13 shows the development of the whiteleg shrimp *Penaeus vannamei* in Latin America, where Ecuador has increased its production five-fold in the last decade, greatly surpassing its main local competitors.

Figure 13 Production of the whiteleg shrimp Penaeus vannamei in America in the 1970-2018 period retrieved from FIGIS FAO



Prepared by: Ecosambito, 2020

Since 2017, shrimps have been the main non-oil international export product of Ecuador. By 2019, the Aquaculture National Chamber of Ecuador (CNA, 2020) informs a shrimp production of 635,222 tons valued US$ 3,652,684,081, and a 25.31% growth in relation to the 2018 period.

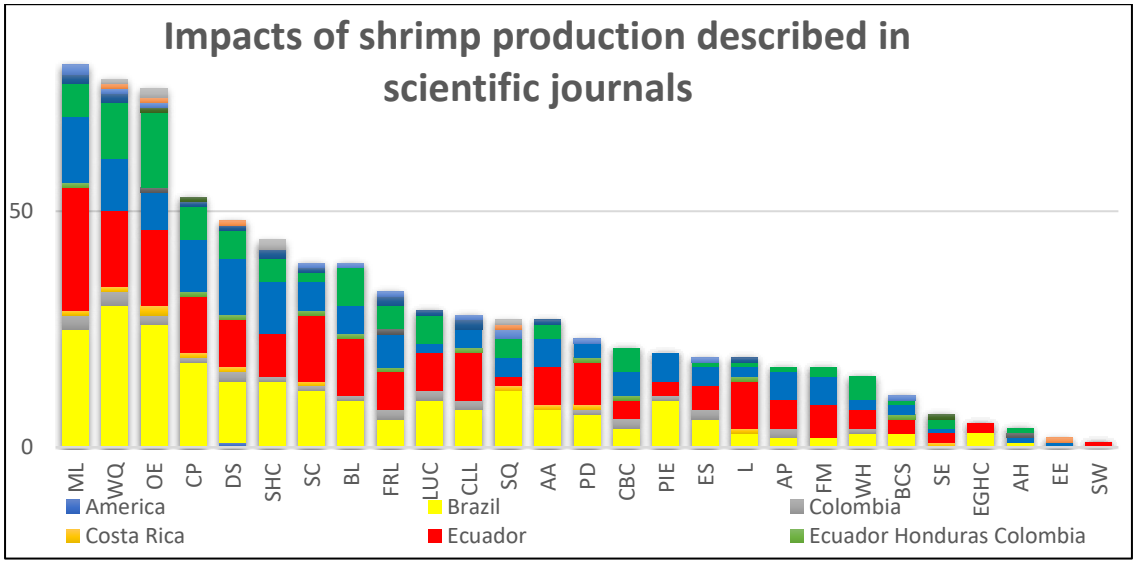
Cantón Machala PDOT document, on its 2018 update, mentions the existence of 7,126.45 ha, and states that “the number of legalized hectares is still being construed due to new regularization deadlines applied to them”, and that around 44,000 ha in El Oro province belong to 921 producers who make 350 million dollar sales.

However, that growth is accompanied by environmental impacts that have been thoroughly discussed in researches and scientific papers, and which are shown in Figure 14. Below is a list of the main impacts:

- Mangrove loss
- Reduction in water quality and organic enrichment
- Chemical pollution

- Disease spread
- Salinization and hydraulic changes
- Social conflicts
- Biodiversity loss
- Fish recruitment lessening
- Land use changes
- Coastal livelihood loss
- Sediment quality
- Antibiotics
- People displacement
- Coastal border changes
- Potentially invasive species insertion
- Erosion and sedimentation,

Figure 14. Impacts of shrimp production described in scientific journals



ML= Mangrove loss, WQ=Water quality reduction, OE= Organic enrichment, CP=Chemical pollution, DS= Disease spread, SHC=Salinization and hydraulic changes, SC= Social conflicts, BL= Biodiversity loss, FRL= Fish recruitment lessening, LUC= Land use changes, CLL= Coastal livelihood loss, SQ= Sediment quality, AA=Antibiotics, PD=People displacement, CBC= Coastal border changes, PIE=Potentially invasive species insertion, ES= Erosion and sedimentation, L=Laws, AP=Abandoned ponds, FM= Fish meal content in feed, WH=Water hypoxia, BCS= Blue carbon storage, SE= Shrimp escapes, EGHC= Emission of greenhouse gases, AH= Anoxia/H2S production, EE= Effects on endangered species, W= Solid waste

Prepared by: Ecosambito, 2020

The above figure clearly shows the undeniable effects shrimp farms have caused in Ecuador, led by its most relevant impact: mangrove loss; alongside related impacts, such as effects on coastal biodiversity as well as in the livelihood of coastal populations.

Mangrove loss has been documented for El Oro province and Cantón Machala. According to the PDOT document and its 2018 update, by 2014 there were 4,011.44 ha of mangroves and 8,236.66 ha of shrimp parcels (22% of the canton's surface).

The undeniable shift of mangroves to shrimp farms and other soil uses was originally documented by Terchunian et al. (1986), from whose document the first record of this ecosystem loss is extracted. The assessment was conducted in the current Machala Puerto Bolívar conurbation for the 1966-1982 period, as is shown in Figure 15, and establishes its relation to shrimp farming and construction activities.

Figure 15. Results of the mangrove loss estimation in the vicinity of Puerto Bolívar during the 1966-1982 period.

Table 1. Changes in land cover/use in the pilot area Machala–Pto. Bolivar, 1966–1982. [Cambios en el uso de la tierra en el area piloto Machala–Pto. Bolivar desde 1966 a 1982.]

	Urban [Urbana]		Mangrove [Manglares]		Shrimp ponds [Camaroneras]		Rivers [Rios]	
Year	ha	%	ha	%	ha	%	ha	%
1966	256.69	3	4692.88	54.84	0	0	1437.45	16.80
1977	434.66	5.08	4231.70	49.50	834.23	9.75	1514.46	17.70
1982	588.50	6.87	3294.08	38.50	2330.67	27.24	1465.65	17.13

Table 1. Continued.

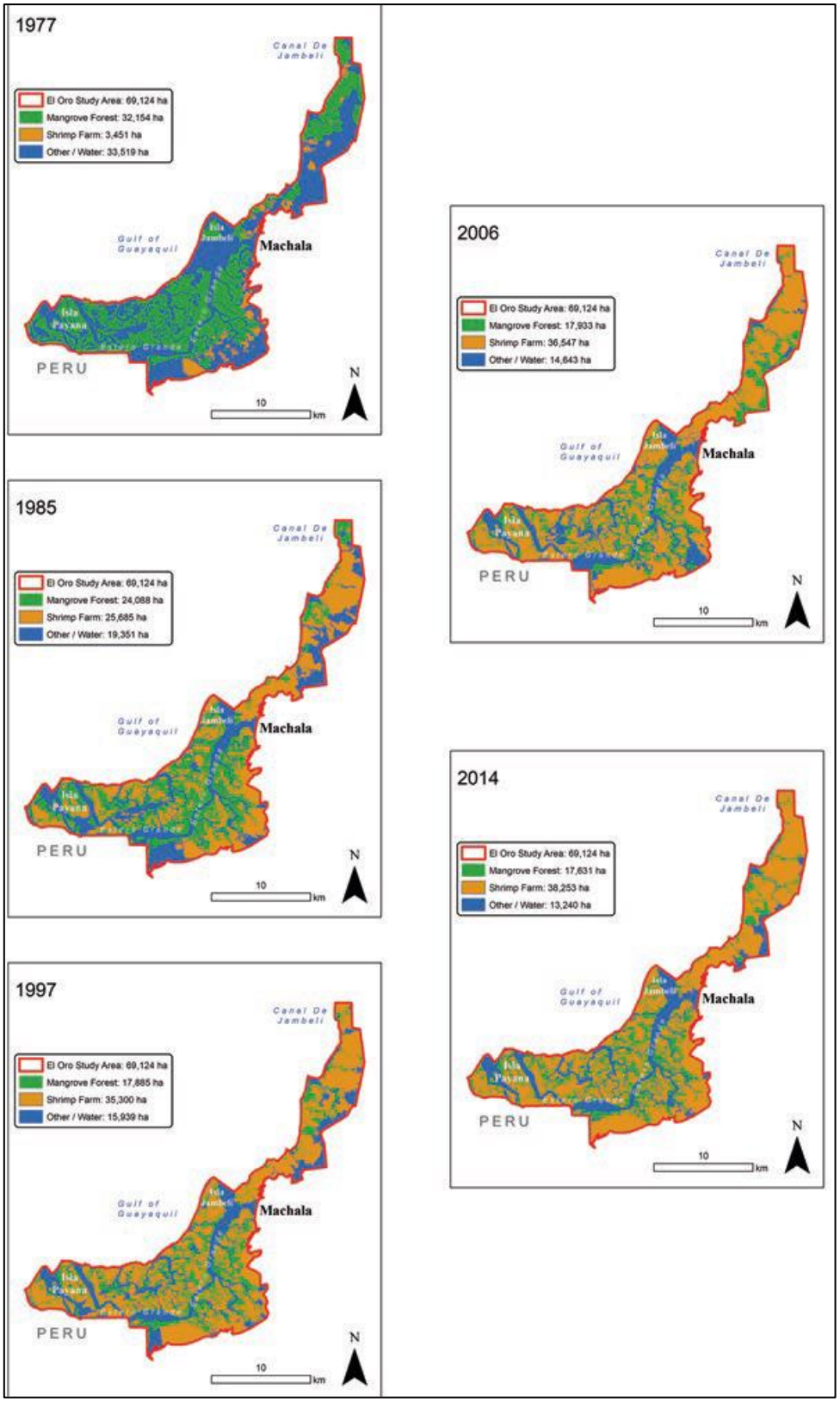
Areas of salt deposits [Salinas]		Upland vegetation [Vegetacion tierra alta]		Agriculture [Zona agricola]		Totals [Totales]		Margin of error
ha	%	ha	%	ha	%	ha	%	
1087.72	12.71	466.32	5.45	615.19	7.19	8556.25	100	±1.80
478.52	5.59	332.15	3.88	730.23	8.54	8555.95	99.98	±0.53
162.56	1.19	139.37	1.63	634.73	7.42	8555.05	99.95	±0.22

Source: Terchunian et al (1986).

These studies were extended by Stuart Hamilton, who publishes in 2019 his book *"Mangroves and aquaculture. A five-decade remote Sensing Analysis of Ecuador´s Estuarine Environments",* from where Figure 16 and Figure 17 are extracted, and which illustrate the scale of mangrove loss and their correlation with shrimp farm activity. Figure 16 shows a change of color from green representing mangroves towards orange associated with shrimp farms during the 1977 to 2014 period.

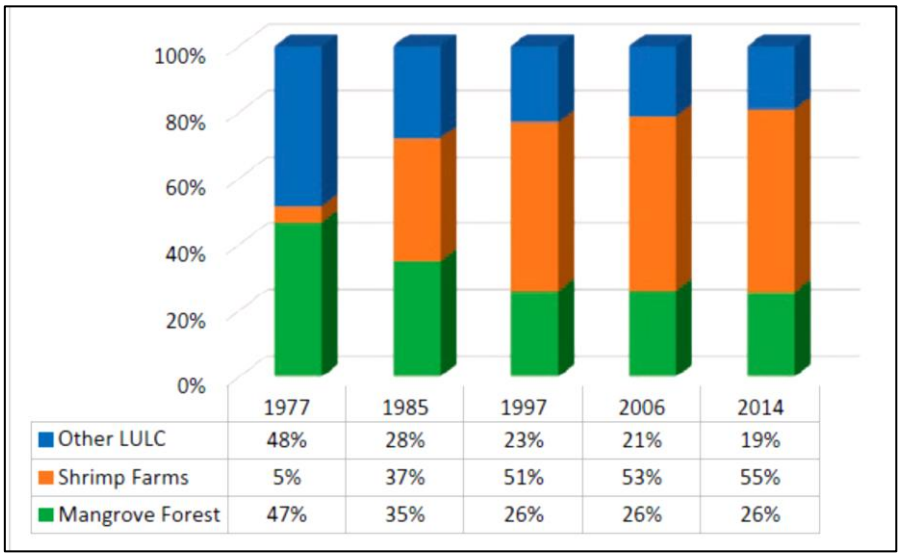
Figure 17 shows that the surface of shrimp parcels in El Oro province is 11 times higher than 37 years ago.

Figure 16 Temporary change in the use of soils associated with estuaries in Jambelí canal and archipelago during the 1977 to 2014 period.



Source: Hamilton, 2020

Figure 17. Development of mangrove area coverage, shrimp farms and other soils uses during the 1997 to 2014 period



Source: Hamilton, 2020.

Impacts on the area's biodiversity and biological productivity cannot be verified due to the lack of past assessments using standard qualitative methodologies which allow for drawing coherent temporal comparisons.

The international recognition of environmental performance of the Ecuadorian shrimp production does not differ much from the assessments published in this report, being mangrove loss its most critical aspect: The Seafood Watch program graded the environmental performance of the Ecuadorian shrimp farms with a score of 5.03 out of 10 (Thompson,2014). Table 10 shows the summarized criteria of such evaluation.

Table 10. "Seafood Watch" evaluation criteria for shrimps produced in Ecuador (Thompson, 2014). Criteria 9 and 10 are regarded as optional

Criterion	Score (0-10)
C1 Data quality and availability	4.75
C2 Effluents	5.00
C3 Habitats	3.77
C4 Evidence or risk of use of chemicals	5.00
C5 Feed	7.70
C6 Escapes	4.00
C7 Diseases, pathogens and interactions with pathogens	4.00
Source of stock, independence of wild fisheries	10.00
Wildlife and predator mortality	-4.00
Escape of intentionally introduced species	0.00
Total	40.22
Final score	**5.03**

As of the “Seafood Watch” presentation to the general public, the industry has improved in some aspects, such as disease management and progressive reduction of chemicals and escapes, but the quality of environmental data is still insufficient; effluent management is almost non-existent, and attention towards adjacent habitats—that is, remains of mangroves and used bodies of water—lack periodic assessments, thus evidencing the absence of official sector-specific regulations. This issue was informed in “Seafood Watch”, which pointed out that although the Ecuadorian environmental legal framework does require EIA for projects, these are general, do not contemplate cumulative impacts and lack a specific framework for aquaculture.

Recent years have seen a tendency towards implementing intensive cultivations, which are much more productive and profitable. This new technology also enables the establishment of shrimp farms in areas far from the coast and using fresh or brackish water. Even though this new cultivation technique allows for more production using less surface, this poses a new threat for other types of habitats such as dry forests and other natural habits remains, as well as for other natural resources, such as surface and subsurface fresh waters.

Transportation and storage

This industry is composed of air transport, land transport and maritime and fluvial transport.

Air transport is performed via the Santa Rosa Regional Airport south of the project area of influence. The airport is currently being underused and barely has two weekly frequencies.

Land transport is performed via passenger and cargo transport services, the latter being closely related to the rest of productive activities, particularly to those associated with exportable products.

The following are the environmental impacts derived from land transport:

- Effects on people’s health, by injuries caused by traffic accidents among vehicles, or with pedestrians.
- Effects on air quality and noise, particularly in urban areas.

Maritime transport is undoubtedly associated with the port activity, but it is not less relevant to shrimp farms supply activities as well as to the fishery industry.

The environmental impacts of maritime traffic are:

- Potential increase in underwater noise. Despite the lack of any national standard, since 2005 the IMO has passed resolutions where the critical issue is to minimize incidental noise addition via the maritime commercial traffic, such as Resolution A.982 (2005), It is important to remember that underwater noise addition is not exclusive to large vessels associated with port activities, but rather common to all motorized vessels.

Meat and shrimp processing and transformation

According to the provincial calculations of the Central Bank of Ecuador, meat and shrimp processing collectively represent $140,783 of added value. This assessment has combined both, since their environmental impacts are similar.

El Oro province has at least 5 shrimp packing plants, at least 3 of which are located in the project area of influence: Marecuador, Promaoro and Marest.

With regard to meat processing, only two of the three local slaughterhouses operate in the project area of direct influence: The Malacha slaughterhouse, recently semi-mechanized, where 520 bovines, 1,600 hogs and 120 goats are slaughtered on a monthly basis, and the Pasaje slaughterhouse, mostly manually operated, which slaughters between 720 and 960 bovines, between 360 and 600 hogs and from 72 to 120 goats each month. (Morán Sánchez, 2014). The third local slaughterhouse within the area of influence, “El Guabo”, was closed down by Agrocalidad together with the Pasaje slaughterhouse in 2013 due poor hygiene or visible health issues. (Diario Hoy, 2013). An interview intended for public officers in these premises revealed that 87% of them state that constructions do not meet the technical requirements for the efficient handling of meat, viscera, non-edible and seized products.

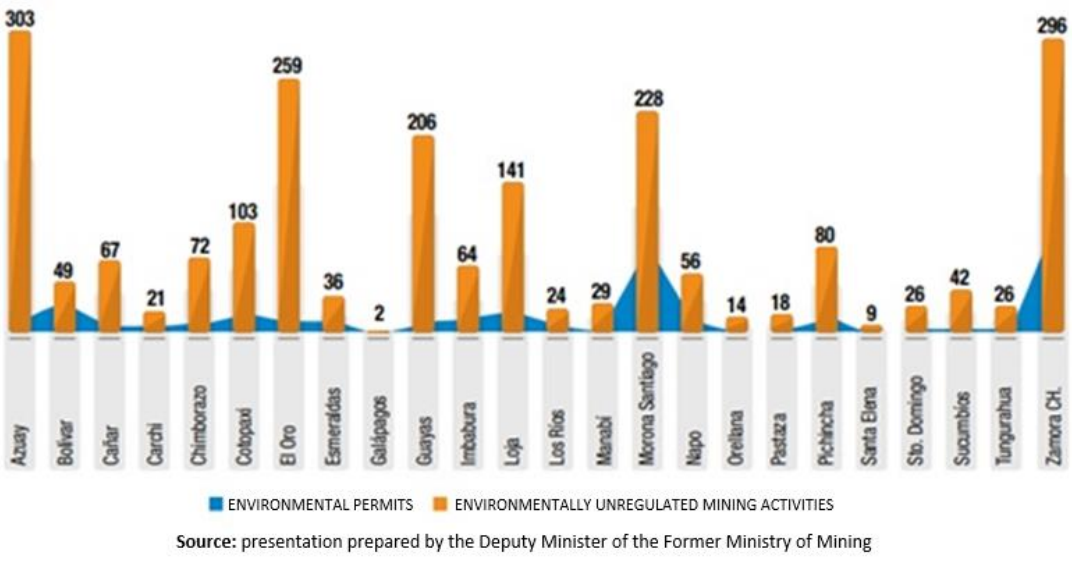
Slaughterhouses and packing plants produce solid and liquid waste which can pollute the environment if they are not treated appropriately:

- The main impact of this industry is the deterioration of water quality. The high organic load present in the effluents of this activities need to be treated prior to their unloading in order to meet the environmental legislation parameters, though in most cases, effluents are discharged without any such treatment.

Mines and quarries.

The sixth largest undertaking in the province what would probable produce major environmental impacts relative to the used surface is mining, with few records of this activity in the area of influence.

Figure 18. Statistics on concessions and environmental regulations



Source: presentation prepared by the Deputy Minister of the Former Ministry of Mining

Source: MEER, 2020

The serious problem regarding mining activities at a national level is its operation outside the Ecuadorian legal framework and regulation. Most of the traditional and small, or even medium mining activities are carried out “illegally” without any formal license granted by the mining authority, least of all with the environmental permits. However, of those mining activities for which there is a legal operating license granted by the Ecuadorian mining authority, very few possess an Environmental Permit (see Figure 18), which exposes a profound lack of knowledge about the real environmental impact of this activity, and grants the assumption that compliance with the environmental standards is little or non-existent.

Peña Carpio and Menéndez Aguayo, 2016, in the publication “Estudio de las colas de tratamiento de oro de la explotación minera en Ponce Henríquez /Ecuador desde una perspectiva ambiental” point out that “in all mining regions in Ecuador, large volumes of waste from mining operations have deposited through time containing considerable amounts of sulfur (pyrite, pyrrhotite). *Since that waste is rarely managed according to desirable standards from an environmental perspective in its disposal, the effect of surface or rain water and atmospheric oxygen gradually cause Acid Mine Drainage (AMD) which pollutes surface and/or subsurface bodies of water”*

Despite Ponce Henriquez political jurisdiction belonging to the Azual province, its relation to El Oro environmental components is explained by their physical proximity to one another, and by its runoff or hydrologic connectivity towards Canal de Jambelí, a body of water which, depending on the local tidal currents, may enter the area of direct influence, thereby becoming another impact to the area of direct influence of Puerto Bolívar. The chemical analysis of Ponce Henríquez mining tailings determined by Peña Carpio and Menénez Aguayo is shown on Figure 19.

Figure 19. Chemical analysis of Ponce Henríquez mining tailings

Chemical analysis of mining tailing samples (Ponce Enríquez-Ecuador). Source: the authors	
Parameters	Value (%)
Antimony (Sb)	<0.03
Arsenic (As)	0.12
Calcium (Ca)	1.22
Cadmium (Cd)	<0.01
Copper (Cu)	0.13
Iron (Fe)	11.51
Magnesium (Mg)	3.07
Lead (Pb)	<0.03
Zinc (Zn)	0.06
Sulfates (SO4=)	0.03
Sulfur (S)	5.84

Source: Peña Carpio and Menéndez -Aguayo 2016.

In 1998, Tarras Wahiberg et al. published *“Environmental impacts of small scale and artisanal gold mining in southern Ecuador” indicating the presence of modest gold mines in the Santa*

Rosa region, 30 km from Machala. The authors compared the quality of water and sediment samples at 4 mining sectors in the south of Ecuador, after identifying the mining processes at Zaruma, Portovelo, Nambija, Ponce Henríquez and Santa Rosa regions, which led to the observation that the polluting levels of arsenic, copper and cadmium were in second place with regard to arsenic and copper concentrations, surpassing Ponce Henríquez and Portovelo in arsenic, and Camilo Ponce in copper and cadmium.

Figure 20 Arsenic, cadmium, copper and mercury concentrations in bodies of water associated with 4 mining centers in the south of Ecuador

		As			Cd			Cu			Hg	
		water dis. µg L^{-1}	water rec. µg L^{-1}	sediment mg kg^{-1}	water dis. µg L^{-1}	water rec. µg L^{-1}	sediment mg kg^{-1}	water dis. µg L^{-1}	water rec. µg L^{-1}	sediment mg kg^{-1}	water dis. µg L^{-1}	water rec. µg L^{-1}
Río Amarillo Portovelo-Zaruma	W	1.7	< 1.0	*35*	*1.5*	*1.4*	*3.6*	*7.6*	1.4	*97.6*	–	0.004
	D	6.8	6.8	*403*	0.7	*2.7*	*19.6*	*23.2*	*142*	*1680*	–	< 0.002
Río Nambija Nambija	W	0.8	2.1	*27*	0.04	0.4	*8.9*	2.3	*71.3*	*336*	–	0.008
	D	2.9	3.0	*1860*	< 0.005	*3.7*	*47.8*	1.3	*395*	*5360*	–	*0.015*
Río Siete Ponce Enríquez	W	35.3	349	*2070*	0.05	0.5	1.8	*13.6*	*19.8*	*2420*	–	0.002
	D	264	*3600*	*7700*	0.05	*2.3*	*6.05*	*11.1*	*33.3*	*2500*	–	1.11
Río Pijili Ponce Enríquez	W	1.9	0.5	7.2	0.02	0.04	0.052	0.7	5.3	24.6		< 0.002
	D	2.1	2.5	454	0.01	< 0.005	0.58	0.3	0.7	578		< 0.002
Río Byron Santa Rosa	W	6.0	14.9	*359*	0.5	0.04	0.6	2.2	3.5	*217*	–	< 0.002
	D	10.8	48.9	*620*	0.2	0.07	1.06	1.4	*5.7*	*303*	–	0.0022
US-EPA (Acute) 25 mg L^{-1} $CaCO_3$		360	360	–	0.8	0.8	–	4.6	4.8	–	–	2.1
US-EPA (Chronic) 25 mg L^{-1} $CaCO_3$		190	190	–	0.4	0.4	–	3.6	3.5	–	–	0.01
EC - Threshold		–	–	5.9	–	–	0.6	–	–	36	–	–
EC - Probable effect		–	–	17	–	–	3.5	–	–	197	–	–

Source: Tarras-Walbergh et al, 1998.

Figure 20 highlights in red the mining fronts of Rio Byron in Santa Rosa, located towards the south of the project area of direct influence, which would be comparatively closer were they connected to Estero Santa Rosa springs

6.2.3. Current undertakings

New services at Puerto Bolívar Port Terminal.

With a view to broadening its services offer to the import and export industry, in addition to the containerized and palletized exportable banana cargo, which constitutes the major sector of managed loads, Yilportecu is currently developing new services, namely:

Ore concentrates export. Services for the mining industry. The export of sealed, containerized copper ore concentrates is to be expected during a first stage (2019-2021), this involves regular management of containers with the required preventive measures in place. The option of managing the “big bags” holding the material and placing it in containers is being contemplated

The goal at a second stage is to implement rotating container technology or “rotainers” which allow for bulk cargo loading onto bulk carriers using a spreader that can rotate the container and place it in the vessel’s hold, in addition to being equipped with a water mist system that releases water particles to prevent dust emissions into the environment.

During the first stage, 136,092 metric tons of concentrates are estimated to be moved, which constitute a monthly load of approximately 12,000 metric tons; whereas for the second stage (beginning in 2022), the annual load is expected to increase to 360,000 metric tons, or 30,000 metric tons per month.

So far, no new structures for appropriate cargo storage in big bags have been implemented; and once the rotainer system is in place, no additional structures will be required in the terminal; instead, the available storage yards will be used.

Solid bulk cargo management. In order to store and distribute grains, Yilportecu may contemplate the construction of several silos with a 45,000 MT capacity, which will be expanded to 75,000 MT if required by demand. The horizontal transportation from the vessel to the silo (import) will be initially carried out with hoppers and dump trucks, which will later be replaced by conveyor belts, depending on the demand.

Storage of carbon, cement, petroleum coke or similar bulk cargoes will be initially performed outdoors, with tarpaulins for cover if need be. This situation will be improved with enclosed silos, probably of the Dome type, when justified by demand.

Ro-Ro. Vehicle reception and storage for the southern region of Ecuador.

6.2.4. Future undertakings

In addition to Puerto Bolívar Project expansion itself, other undertakings intended for the project area of influence have been identified. It is worth mentioning that significant undertakings currently being performed in the area, such as banana and shrimp cultivation, will not be able to expand in a meaningful way since useful soils intended for these activities are already occupied. Nonetheless, these activities can be carried out in a more intensive manner, as is the case with shrimp cultivation, which is currently shifting towards the intensive cultivation technology, even in fresh water.

Puerto Bolívar Expansion Project. The most relevant future undertaking within the project area of influence, and which is certain to be realized, is the expansion project of Puerto Bolívar itself, devised in 3 stages so that load bearing capacity can be gradually incremented. Such stages are developed north of the current project.

Table 11. Stages of Puerto Bolívar Expansion Project, planned during the license term of Yilportecu S.A.

Stage 1	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5
Access canal	-16.5 m	-16.5 m	-16.5 m	-16.5 m	-16.5 m
Pier	750 m (at -16.5 m) 610 m (-12 m)	750 m (at -16.5 m) 610 m (-12 m)	750 m (at -16.5 m) 610 m (-12 m)	1,065 m (at -16.5 m) 610 m (-12 m)	1,065 m (at -16.5 m) 610 m (-12 m)
Yards	• Container yard expansion • New RTG blocks • Grain silos • Cold-storage warehouse • Yard remodeling	• Container yard expansion • New RTG blocks • On-demand storage facility expansion	• Container yard expansion • New RTG blocks • On-demand storage facility expansion	• Container yard expansion • New RTG blocks • On-demand storage facility expansion	• Container yard expansion • Solid bulk cargo silos expansion

Stage 1	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5
Additional equipment	• 2 mobile cranes • 4 STS cranes • 12 RTG • Ancillary equipment • 1 tugboat • Possible acquisition of hopper and damp trucks	• 1 mobile crane • 2 STS cranes • 6 RTG • Ancillary equipment	• 2 STS cranes • 6 RTG • Ancillary equipment	• 3 STS cranes • 10 RTG • Ancillary equipment	• 3 STS cranes • 16 RTG • Ancillary equipment
Capacity (TEUs)	600,000	1,000,000	1,500,000	2,100,000	2,600,000
Duration/activation factor	2 years	4 years 500,000 TEU	10 years 850,000 TEU	15 years 1,300,000 TEU	46 years 1,800,000 TEU

Source: Yilportecu S.A.

STAGE 1. This stage will be built between 2021 and 2022 and shall be operational in March 2023. It includes the construction of a pier 450 meters long, 62 meters wide and with a depth of -16.5 meters below the mean low water springs level (MLWS), for the mooring of container ships of up to 200,000 deadweight tons (DWT), and a container yard of 12 hectares for container storage (full dry, refrigerated and empty). It will also be equipped with 4 STS (ship to shore) pier cranes and 12 RTG (rubber tire gantry) yard cranes for piling up containers in the yards. It will provide all basic services, an electrical supply system for all load handling equipment and an emergency power system. Moreover, other loading segments will be developed through the construction of infrastructures for cereals and other solid bulk cargo, such as cement, clinker, copper, etc.

This stage will allow for an increased reception and load handling capacity of containers in Puerto Bolívar up to 600,000 TEU.

STAGE 2. When the operating capacity is about to reach 600,000 TEU during stage 1 realization, Yilport will commence stage 2 which consists in the construction of additional container yards and the acquisition of additional equipment for container handing: 2 additional STS cranes and 6 RTG cranes, as well as an increased number of additional equipment for container handling and transportation, which will enable a reception and handling capacity of 1,000,000 (one million) TEU.

Stage 2 construction, subject to the cargo containerization percentage in El Oro province and the arrival of cargo from nearby provinces, in addition to cargo from the north of Peru, may be carried out between 2031 and 2032.

STAGE 3. Mainly consists in the construction of additional container yards and the acquisition of additional equipment for container handling: 2 additional STS cranes and 6 RTG cranes, as well as an increased number of additional equipment for container handling and transportation, which will enable Puerto Bolívar to reach a reception and handling capacity of 1,500,000 (one million) TEU.

The development of stages 2 and 3 is to take place several years from now, and many development factors need to occur both in Ecuador's economy and in local maritime transport in order for such a large volume of containers to be moved from Puerto Bolívar; therefore, it is too early to identify very precise development patterns.

Consequently, Yilport may be more inclined to carry out a gradual development of container yards, a cheaper and eco-friendlier solution, as shown in Figure 21

Figure 21. Gradual development of container yards for stages 2 and 3.

Source: Yilportecu S.A.

The figure shows the partial development of Stage 2 (green rectangle) using only an area of land at a first stage, leaving the coastal line and the maritime area behind pier #6 untouched (transparent green rectangle), which will be assigned to future construction works at a later stage.

This development will enable the accommodation of 4 new container blocks for RTG cranes with a capacity of 1,540 FEU (Forty Equivalent Units) and a 200,000 TEU increase in container storage capacity.

The same model may be repeated in stage 3, in which the mainland yards will be developed (yellow rectangle), the coastal line will be left untouched (transparent yellow rectangle) and

only an access to Pier #6 will be built to ease container circulation between the pier and the new yards, thereby optimizing the Terminal operation.

As a result, neither the coastline nor the small mangrove shrubs found at a corner of the beach will be affected in any way during stage 2, as seen in Figure 21 at the transparent green area.

STAGE 4. At the fourth stage, piers and yard will be extended and new equipment will be bought so as to reach an annual capacity of 2,100,000 TEU. The activation factor for this stage would be to reach a traffic of 1,300,000 TEU.
This stage consists in the construction of a pier measuring 315 m, reaching a total of 1,065 m with a 16 m draft, and 610 m with a 12 m draft. Besides, it contemplates the expansion of storage and container yards, equipment and acquisition of 3 STS cranes and 10 RTG cranes. Moreover, it contemplates the possibility of expanding the tugboat fleet according to the demand and the established quality criteria.
STAGE 5. The fifth stage consists in a new and final expansion of the container yard and the purchase of new equipment so as to reach an annual capacity of up to 2,600,000 TEU. The activation factor for this stage would be to reach a traffic of 1,800,000 TEU.
It contemplates the construction of yards intended for containers with RTG blocks, three STS cranes in piers, 16 RTG cranes in yards, and the ancillary equipment required for a smooth operation
Tugboats: Possibility of expanding the tugboat fleet according to the demand and the established quality criteria.

Mooring piles, walkway and supplementary works located at Canal de Jambelí. This project, which will be carried out within the area of direct influence, is in the process of acquiring an Environmental Permit. According to the EIA (Consulsua, 2020), it consists in the implementation of special structures that serve as mooring points for vessels. The operation will consist in the berthing of vessels, storage of liquid and gas hydrocarbons, distribution of hydrocarbon and maintenance of port facilities. The project will be linked with the gas pipeline that connects Amistad platform to Bajo Alto Natural Gas Liquefaction Plant. Transfer of gas is not being contemplated at this time since prior to that an environmental license needs to be granted by the operators of said gas pipeline belonging to Petro Amazonas. At its operational stage, permits will be valid for 10 years, whereas the license to the area will be in force for 50 years.

Estero Huaylá dredging project. This project belongs to the Autonomous Provincial Government of El Oro, and consists in the dredging of 3 of the 4.27 km of this marsh, and in the extraction of 454,000 cubic meters of sediment. The expected dimensions are -3.5 meters in draft at low tide, and 40 meters wide. The aim is to ensure fishing vessel navigation without tidal restrictions and to remedy the environmental impact caused by pollution (available at https://www.eloro.gob.ec/post/prefecto-entreg%C3%B3-a-yilport-proyecto-para-dragar-estero-huayl%C3%A1). Even though an Environmental Impact Assessment was conducted for this project, it is currently in search of financing by the Province's Decentralized Local Government of Machala (GAD).

Puerto Cobre. This 27-hectare project located north of Puerto Bolívar Port Terminal consists in the construction of port facilities and the storage and loading onto bulk carriers of copper concentrates from mining concessions in the Zamora province.

The proposed pier is a wharf type or marginal pier measuring 170 m long and 3.6 m wide, plus a service platform (main dolphin) 20 m long and 12 m wide, with 4 additional mooring dolphins (2 on each side), with an axle spacing of 50 meters. Dredging works will also be required at a depth of 10.75 meters, with an over-dredge of 11 meters, which represents 180,000 cubic meters (Ecosambito, 2007).

The project has an Environmental License and is up to date with its environmental obligations, although its construction date is unknown.

Estero Jelí dredging. According to the available information source[4], this undertaking consists in the excavation and evacuation of sediments from Rio Santa Rosa, Río Buenavista and Río Pital that accumulate at the mouth of Estero Jelí (located 17 km south of Puerto Bolívar, within the area of indirect influence), to prevent sediment accumulation from causing restrictions in the entry of local shrimp and traditional fishermen. Dredging procedures will be carried out in three specific locations: from Estero Santa Rosa until near Puerto Jelí gas station (3,600 m), at the inner harbor facing Puerto Jelí (500 m), and upstream of Río Pital, at the stretch between Puerto Pital and the Pan-American Highway bridge (5,700 m). From the marsh entrance until near the aforementioned bridge, its total length is 9,800 m. A dredged sediment disposal site has been stipulated at Hacienda La Emereciana located 1,400 m from Puerto Jelí promenade.

This project has had an Environmental License since 2012, even though activities were halted by the Ministry of Environment for failure of compliance with the environmental obligations. The performance of operations is still pending.

Cangrejos mining project. Cangrejos is an open-pit mining project for gold and copper located between parishes Bella María and San Juan de Cerro Azul, at cantons Santa Rosa and Atahualpa in El Oro province, 40 km east of Puerto Bolívar, licensed to Odin Mining del Ecuador S.A., subsidiary of Lumina Gold from Canada, an exploration and mining development company based in Quito (BCE, 2021).

A 20-year service life is estimated, with an annual production of 373,000 ounces of gold and 43 million pounds of copper. A processing plant is being planned consisting of a conventional copper and gold flotation concentrator and a CIL circuit (carbon in leach) which will manage 40,000 t/d during the first five years. As of year six, the capacity will increase twofold to 80,000 t/d for the remainder of the mine service life. The plant is designed to produce gold and silver doré, copper and gold flotation concentrates and molybdenum concentrate.

The Cangrejos project has 10 concessions: Los Cangrejos, Los Cangrejos 11, Cangrejos 10, Cangrejos 20, Cangrejos A, Cangrejos B, Cangrejos C, Cangrejos D, Casique and Canarias. The Ministry of Environment granted an advanced exploration license to Los Cangrejos concession, and an initial exploration license to Cangrejos 20 with its advance exploration license in process.

[4] Available at https://maeeloro.files.wordpress.com/2013/11/esia-dragado-estero-jelc3ad.pdf

Up until the third quarter of 2020, the Cangrejos project has not defined the extraction method, nor has it set the commencement date for the construction of the mine.

6.3. Summary of undertakings.

Table 12 shows a list of preexisting, current and future undertakings near the project as well as its characteristics.

The Cumulative Impact Assessment is forward-looking, therefore, based on descriptions of the undertakings performed in previous sections and the incremental analysis of economic activities, some preexisting undertakings can be dismissed on the basis of not being potentially expandable in a meaningful way at a later time due to financial, legal and spatial constraints. Likewise, future projects whose realization is uncertain will be ruled out. The gray rows in table 12 highlight those undertakings which have been promoted to the next stage of the analysis, and subsequent paragraphs provide explanations about preexisting undertakings.

Table 12. Definitive undertakings

Undertakings		Areas of influence	Environmental License	Service life (years)	Future activity expansion in the areas of influence	Future realization
Preexisting	Puerto Bolívar Port Terminal	Direct	Yes	80		
	Campo Amistad	No	Yes	40	No	
	Termogas Machala	Indirect	Yes	40	No	
	Bajo Alto Natural Gas Plant	Indirect	Yes	40	No	
	Growing of banana, cocoa and coffee crops	Direct	Partial	20	No	
	Construction	Direct	Partial	40	No	
	Shrimp aquaculture and fishery	Direct	Partial	20	Implementation of intensive cultivation	
	Transportation and storage	Direct	Partial	10	No	
	Meat and shrimp processing and transformation	Direct	Yes	30	No	
	Mines and quarries	No	Partial	20	Rise in illegal mining	
Current	New services at Puerto Bolívar Port Terminal.	Direct	Yes	80	---	---
Future	Expansion of Puerto Bolívar Port Terminal	Direct	Yes	80		Certain
	Mooring piles, walkway and supplementary works	Direct	Pending	40		Certain
	Estero Huaylá dredging project	Direct	Yes	5		Certain

Undertakings		Areas of influence	Environmental License	Service life (years)	Future activity expansion in the areas of influence	Future realization
	Puerto Cobre	Direct	Yes	80		Certain
	Estero Jelí dredging	Indirect	Yes	5		Uncertain
	Cangrejos mining project	No	Exploration	20		Unknown date of exploitation

Prepared by: Ecosambito, 2020

Table 12 includes a column with the datum “Certainty of activity expansion in the area of influence” for preexisting undertakings, given that some activities may continue to operate under the same conditions in the short and medium term, whereas others may expand their operations and thus contribute to future cumulative impacts.

Therefore, the existing undertakings, namely Campo Amistad, Termogas Machala and Bajo Alto Natural Gas Plant, have no certainty as to the expansion of their activities in the short and medium term according to the consulted sources. As to the productive activities in the province, the following observations have been made:

- Growing of banana, cocoa and coffee crops: banana plantations alone cover 35% of the province surface. This activity, which is developed in flat lands and whose production has seen an incremental tendency in the last years, cannot increase it further in a meaningful way since it has already occupied all the soils it can use. Instead, it could reduce its impact in the area of influence by replacing its current production with a much better priced organic produce, also due to the urban growth pressure.
- *Construction.* This activity is mainly associated with future project of provincial and local relevance. Given its connection to regional economic dynamics, a reduction in its impact is expected due to the low rate of economic growth projected for the next years in Ecuador.
- *Shrimp aquaculture and fishery.* This preexisting activity in one of the most relevant ones at a provincial level, and it undoubtedly relates to some of the environmental components of the assessed project, though there are legal constraints on soil use in mangrove-covered areas, which have already occupied most surfaces suitable for the activity. As for shrimp farming, the current tendency is a shift in technology towards intensive cultivation, in which seed density, and thus productivity per hectare, is up to 25 times higher. This type of cultivation can be performed with fresh water, typically from a well, at the expense of higher energy and input demands, which leads to changes in environmental effects and future environmental conditions.
- *Transportation and storage.* Another activity closely related to the rest. It was decided that it be excluded from the analysis given its overlap with other undertakings.
- *Meat and shrimp processing and transformation.* As far as meat is concerned, this activity is facilitated by domestic demand, whereas the processing of shellfish such as shrimp is intended for export. No incremental tendency is observed as processing

plants and slaughterhouses have maintained their production levels and no expansion projects are known for this activity.

- Mines and quarries. This activity shows a significant growth at a national level with an emphasis on gold and copper metal mining. In both El Oro and the neighboring and nearby provinces of Azuay and Zamora there are proven and formal leased reserves in an advanced exploitation and exploration stage. However, as was previously mentioned, a large proportion of the mining activity is carried out illegally, which makes it impossible to establish its actual scope, temporal development and effects on ecosystems. It is therefore assumed that this activity has a great potential for ongoing growth in the coming years, which is why it was included in future cumulative impact assessments.

7. Definition of definitive geographical and temporal limits for EGIA

Puerto Bolivar Expansion Project Stage 1 will perform a physical expansion of piers towards the norther area which, even though it prolongs by 450 m, does not imply an increase in the geographical limit of direct influence. Expansion Stages 2 and 3 contemplate the construction of container and storage yards in the area near the new pier, whereas Stages 4 and 5 involve the construction of a new pier measuring 315 m with is corresponding yards and equipment.

Prior to the commencement of expansion stages subsequent to Stage 1, certain established goals associated with load demand need to be reached which serve as “triggers”; therefore, no implementation deadlines have been defined. However, these expansions are expected to be carried out during Yilportecu’s 50-year license period. Expansion stages subsequent to Stage 1 will require their individual assessments and analysis of alternatives in order to determine their final designs, environmental impacts, and preventive, mitigating, restoration or compensation measures. Nevertheless, an undisputed impact of this expansion will be the increased maritime traffic of higher capacity vessels, in addition to the transportation of new loads such as mineral concentrates and bulk cargoes.

Other assessed undertakings share the same field of activity as preexisting and current ones, as well as their estimated service lives, and the already established 50-year term. Therefore, the definitive geographical limits are kept within the current area of indirect influence previously defined, and the project temporal limit remains at 50 years, commencing in 2016.

8. Identification of definitive VECs and undertakings

Table 13 shows a summary of the interactions between definitive undertakings and the 12 environmental components identified for Puerto Bolívar project. Valued Environmental and Social components (VECs) are those which have interactions with more than two undertakings (influence equal or higher than 33%). In Table 13, selected VECs are shown in gray.

Puerto Bolívar Port Terminal undertaking takes into account both its preexisting operation and future expansion.

Table 13. Interactions among undertakings, cumulative impacts and environmental components in the area of influence of Puerto Bolívar project

Environmental components	UNDERTAKINGS						
	Puerto Bolívar Port Terminal	Shrimp aquaculture and fishery	Mines and quarries	Mooring piles in Canal Jambelí	Estero Huaylá dredging	Puerto Cobre	Influence of undertaking on VEC
Water and sediment quality	X	X	X	X	X	X	100%
Air quality and noise	X						17%
Soil quality	X	X	X		X		67%
Land traffic	X						17%
Maritime traffic	X	X		X	X	X	83%
Biodiversity	X	X	X			X	67%
Community health and safety	X		X				33%
Community relations	X						17%
Economy	X	X	X	X	X	X	100%
Tourism	X						17%
Cultural heritage	X						17%
Fisheries	X	X				X	50%

Prepared by: Ecosambito, 2020

9. Cumulative Impact Analysis Methodology

The modified Leopold Matrix will be employed for the assessment of cumulative impacts and to determine its significance and hierarchy. This matrix shows the potential environmental impacts identified for the physical, biotic and human components and determines the significance of the associated impacts. The classification process for environmental impacts

considers all project stages with an emphasis in construction activities and their effects on both the natural and socio-economic environment within the area of influence.

The assessment will apply previously defined criteria, which will be assessed by means of semi-quantitative parameters established on a relative scale, such that every project activity correlates with the corresponding environmental impact produced. This assessment creates an index reflecting the quantitative and qualitative characteristics of the impact.

On the basis of assigning values within the corresponding ranges of each criterion, a matrix is generated which determines the significance and hierarchy of the different impacts, and which by means of a formula that includes all the assessed criteria, a numerical value is obtained that allows for drawing comparisons (CA).

Table 14. Evaluation criteria and value ranges.

Symbol	Criterion	Value range
D	Direction	-1 to +1
M	Magnitude	0 to 3
Du	Duration	1 to 3
R	Reversibility	0 to 3
E	Geographical expanse	1 to 3
F	Frequency	0 to 4
Po	Probability of occurrence	0.1 to 1

The environmental classification for each impact (CA) is the result of the interaction of each criterion to determine the characteristics of the environmental impacts. The classification is shown in the following equation: CA= D x Po x (M + E+ Du + F + R).

Environmental Assessment Criteria

The application of the criteria depends on the environmental assessment being conducted, as well as on the environmental sensitivities of the components that have been identified in field and reference studies.

Table 15. Semi-qualitative analysis of the Environmental Assessment criteria

Semi-qualitative analysis	**Value range**	**Description**
DIRECTION (D)		
Negative	-1	Net damage to the resource
Positive	1	Net benefit to the resource
Neutral	0	No benefit or harm to the resource
PROBABILITY OF OCCURRENCE (Po)		
High	1	When the appearance of the effect is known with certainty
Medium	0.9± 0.5	Likely, the probability of occurrence is high
Low	0.4± 0.1	Low probability of occurrence
MAGNITUDE (M)		
High	3	Predictable effects exceed the limits associated with potential adverse effects, or cause a detectable change in environmental aspect, beyond the natural variability or social tolerance

Medium	2	The effects are considerably above typical existing conditions, but do not exceed the criteria defined in the allowable limits or cause changes in the economic, social or biological parameters below the ranges of natural variability or social tolerance
Low	1	It is estimated that the disturbance will be slightly higher than the typical existing conditions
None	0	No change is expected
GEOGRAPHICAL EXPANSE (E)		
Regional	3	It extends beyond all sub-regional or administrative limits specified for each discipline or indicator, but confined to the region.
Sub-regional	2	Extends beyond the directly disturbed areas, but is within the limits of the assessed area (generally 1 km or less from the disturbed areas)
Local	1	Confined to the area directly disturbed by the project
DURATION (Du)		
Long	3	More than a year
Medium	2	Between 6 and 12 months
Short	1	Less than 6 months
FREQUENCY (F)		
Continuous	3	Will occur constantly
Isolated	2	Confined to a specific period
Occasional	1	Occurs intermittently but repeatedly
Accidental	0	Rarely occurs
REVERSIBILITY (R)		
Irreversible	3	Permanent effects
Reversible in the long term	2	Can be reversed in more than 1 year
Reversible in the medium term	1	Can be reversed in between 6 and 12 months
Reversible in the short term	0	Can be reversed in 6 months or less

Impacts hierarchy

Environmental impacts classified for all the environmental components are assessed according to the significance criteria using the following value ranges:

Table 16. Significance value ranges

Range	Environmental classification	Color code
0 to 15	Positive	Blue
-5 to 0	Mild negative	Yellow
-10 to -5.1	Moderate negative	Orange
-15 to -10.1	Severe negative	Red

10. Cumulative Impact Assessment

10.1. Assessment of the individual impacts of each undertaking on VECs

The following matrix shows the assessment of individual impacts of the undertakings on each VEC by applying the above methodology.

Two indicators have been defined at each row end.

Average impact on VECs: it is the arithmetic mean of the contribution of each undertaking to VEC, such that it is shown in the same value range of the classified impacts by undertaking; therefore, its color shows the impact significance degree on the VEC.

Total impact on VEC: shows a total accumulated value of all impacts caused by the undertaking on each VEC. This value may be useful for identifying the VEC that receives the highest cumulative impact.

The result shown in the columns constitutes the cumulative impact contributed by a specific [*sic*] on the assessed VEC. This impact has been classified as positive impact and negative impact, and is shown both in value and [*sic*].

Table 17 shows the cumulative impact assessment results arranged in order of significance. The matrix containing the semi-qualitative analysis of the Environmental Assessment criteria appears in Annex 3 of this document.

Table 17 Assessment matrix or cumulative impacts arranged in order of significance

	UNDERTAKINGS							
VEC	Puerto Bolívar	Aquaculture	Mines	Mooring piles	Huaylá dredging	Puerto Cobre	Average impact on VECs	Total impact on VECs
Water and sediment quality	-4.8	-6	-13.5	-4.8	-6	-4.8	-6.7	-39.9
Soil quality	-0.8	-5.5	-6.5		-5.4		-4.6	-18.2
Maritime traffic	-5.5	-5		-5.5	4	-5.5	-3.5	-17.5
Biodiversity	-5.5	-5	-6.5			-5.5	-5.6	-22.5
Economy	14	12	13	12	13	13	12.8	77.0
Fisheries	-1.5	-1.2				-1.5	-1.4	-4.2
Negative cumulative impact by undertaking	**-18.10**	**-22.70**	**-26.50**	**-10.30**	**-11.40**	**-17.30**		
% of negative cumulative impact	**17%**	**21%**	**25%**	**10%**	**11%**	**16%**		
Positive cumulative impact by undertaking	**14.00**	**12.00**	**13.00**	**12.00**	**17.00**	**13.00**		
% of positive cumulative impact	**17%**	**15%**	**16%**	**15%**	**21%**	**16%**		

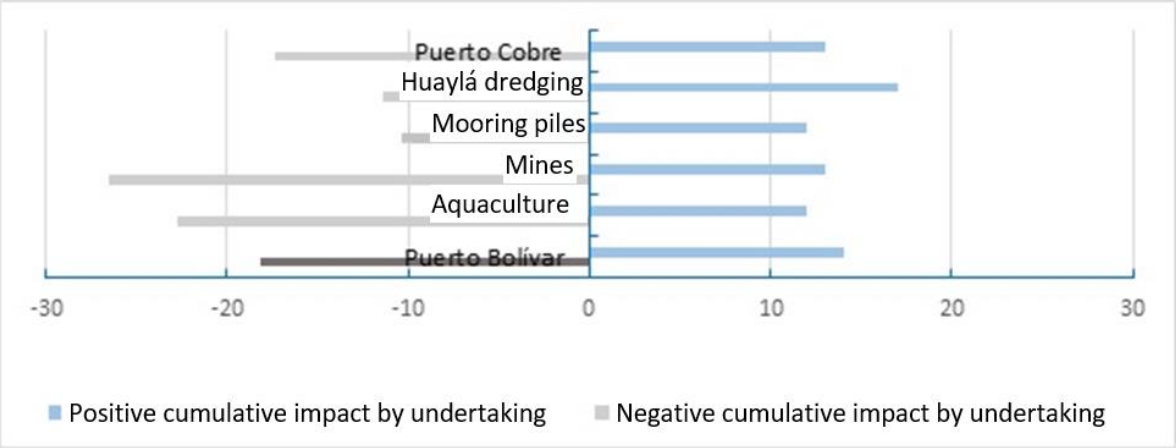
Prepared by: Ecosambito, 2020

10.2. Results

10.2.1. Cumulative impacts of the undertakings

This assessment shows the degree in which each undertaking produces an impact on all the assessed VECs. The right side of Figure 22 shows the positive impacts of the undertakings on VECs, calculated on the basis of their contribution to the local and regional economy, whereas the left side shows the negative cumulative impacts on VECs.

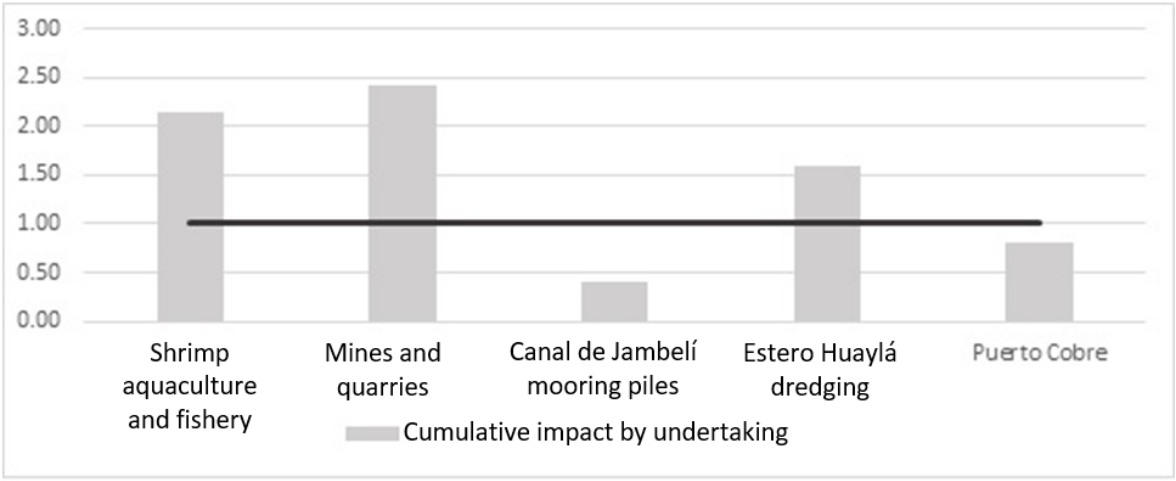
Figure 22. Cumulative impacts by undertaking



Prepared by: Ecosambito, 2020

The assessed contribution of the undertakings to Puerto Bolívar project are shown in Figure 23. To that end, the values pertaining to the impacts of undertakings on VECs have been normalized based on the values of impacts of Puerto Bolívar project, so as to assess and compare the cumulative impacts of the undertakings in proportion to those of the Project. This assessment only contemplates the negative impacts.

Figure 23. Cumulative impacts by undertaking in relation to the impacts of Puerto Bolívar project.



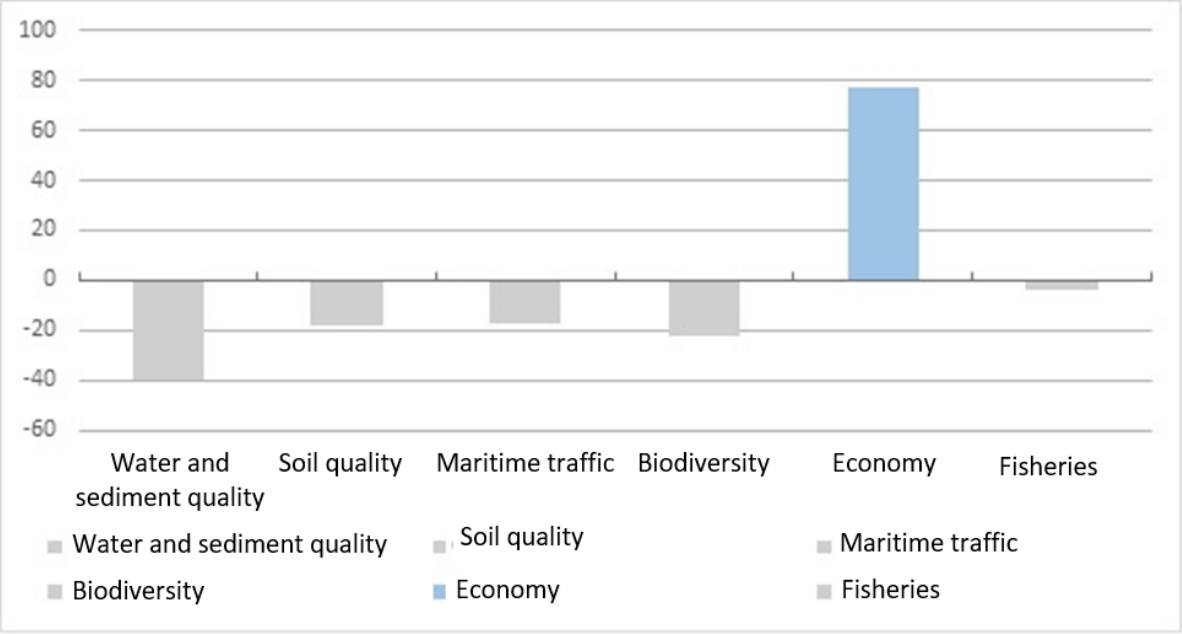
Prepared by: Ecosambito, 2020

This figure illustrates that the major contributors to cumulative impacts are aquaculture, with a future emphasis on intensive and super-intensive shrimp cultivation, and mining, which mainly operates illegally and whose growth and operation is largely performed outside government control.

10.2.2. Cumulative impacts on VECs

The figure below shows the net cumulative impacts of all assessed undertakings received by each VEC.

Figure 24. Cumulative impact on VECs



Prepared by: Ecosambito, 2020

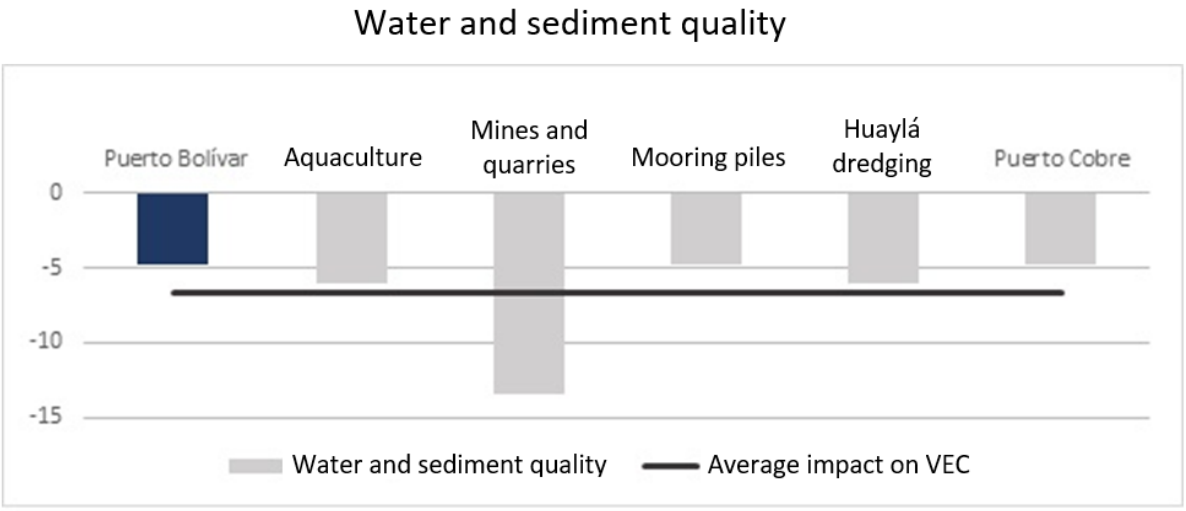
As seen in Figure 24, water and sediment quality as well as biodiversity are the VECs most affected by the assessed undertakings since they have more interactions with them, and among the effects they receive are moderate and severe impacts, whereas the economy receives a positive cumulative impact.

The obtained results for each assessed VEC regarding the cumulative impact of each undertaking is shown below:

- in relation to the total average of impacts for each assessed VEC (Average impact on VEC);
- in relation to the project impact (normalized absolute value).

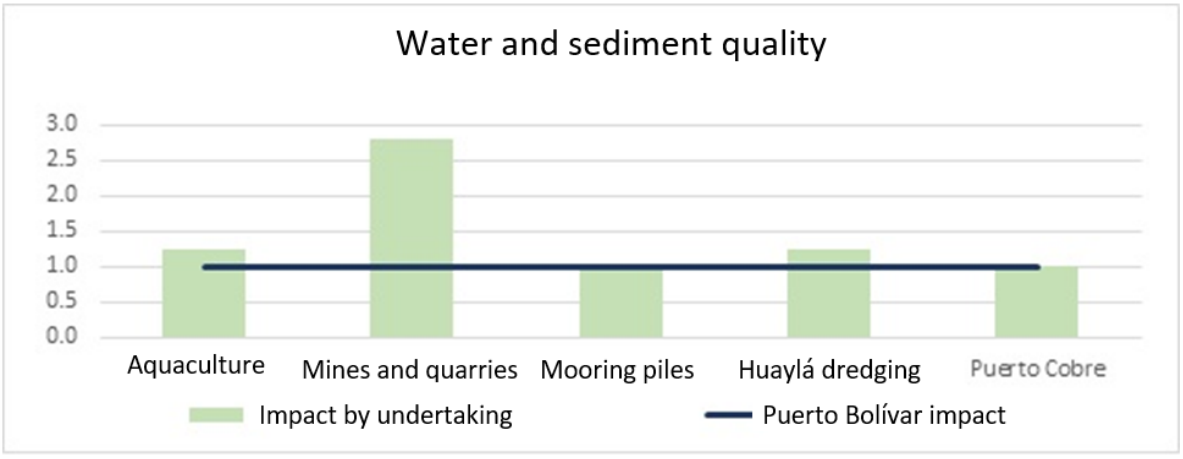
Water and sediment quality. This VEC has one of the most interacted with by other undertakings. Despite the descriptions of current conditions indicating that the marsh and adjacent marine areas are highly resilient, possibly due to the presence of the mangrove ecosystem in its vicinity, the close monitoring of its quality must continue, especially of heavy metal concentrations which could affect some regions irreversibly. Mining is unarguably the most significant contributor to the decline of this VEC, immediately followed by agriculture.

Figure 25 Cumulative impacts by undertaking against Average impact on water and sediment quality



Prepared by: Ecosambito, 2020

Figure 26 Cumulative impacts by undertaking against the Project in relation to water and sediment quality

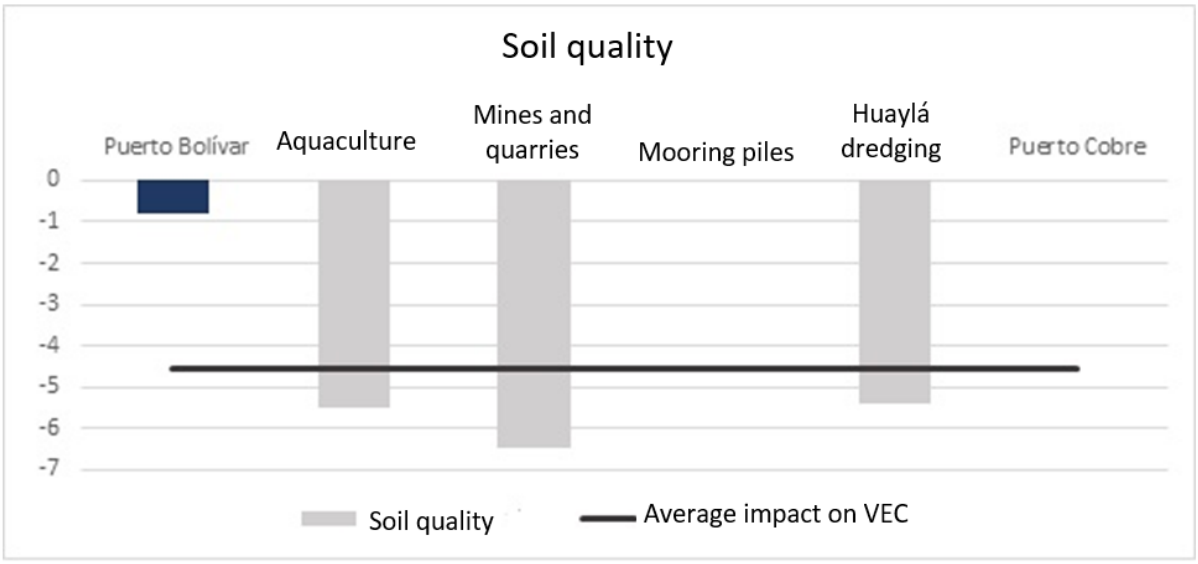


Prepared by: Ecosambito, 2020

Soil quality

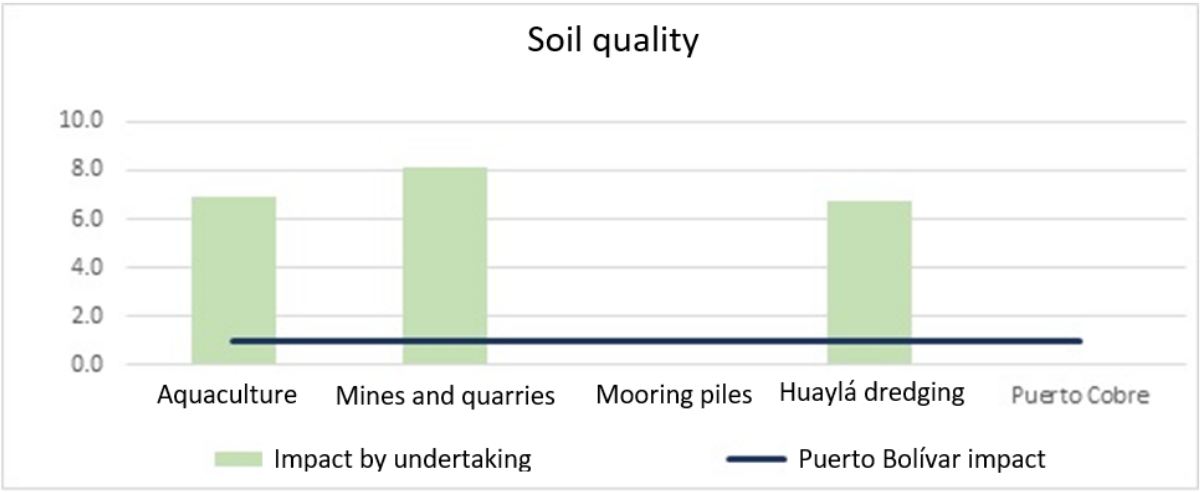
Soil quality is severely affected by cumulative impacts. Agriculture, which constantly changes the characteristics of the soil, and the dredging of Estero Huaylá, whose sediments are presumed to be heavily contaminated and should be disposed of in the mainland, significant contributors to this result.

Figure 35 Cumulative impacts by undertaking against Average impact on soil quality



Prepared by: Ecosambito, 2020

Figure 28 Cumulative impacts by undertaking against the Project in relation to soil quality

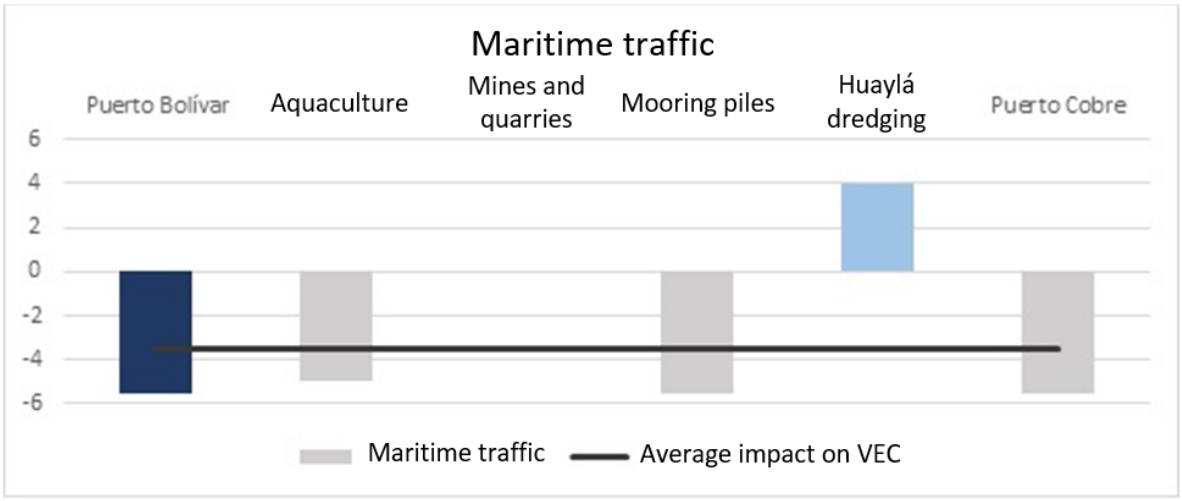


Prepared by: Ecosambito, 2020

Maritime traffic

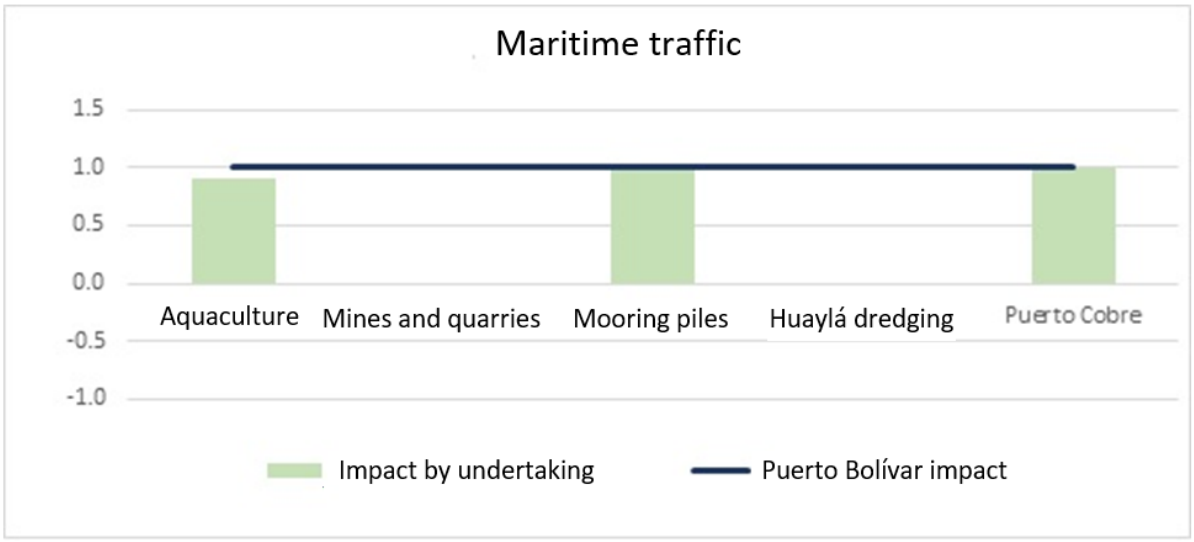
This VEC receives both positive and negative effects. Maritime traffic is heavy in the area of influence and even more so in the vicinity of Puerto Bolívar. The dredging of Estero Huaylá could prove beneficial to this VEC, although without any control by the authorities on the number of vessels with a license to operate in the area, this effect could become adverse in the medium term.

Figure 35 Cumulative impacts by undertaking against Average impact on maritime traffic



Prepared by: Ecosambito, 2020

Figure 30 Cumulative impacts by undertaking against the Project in relation to maritime traffic

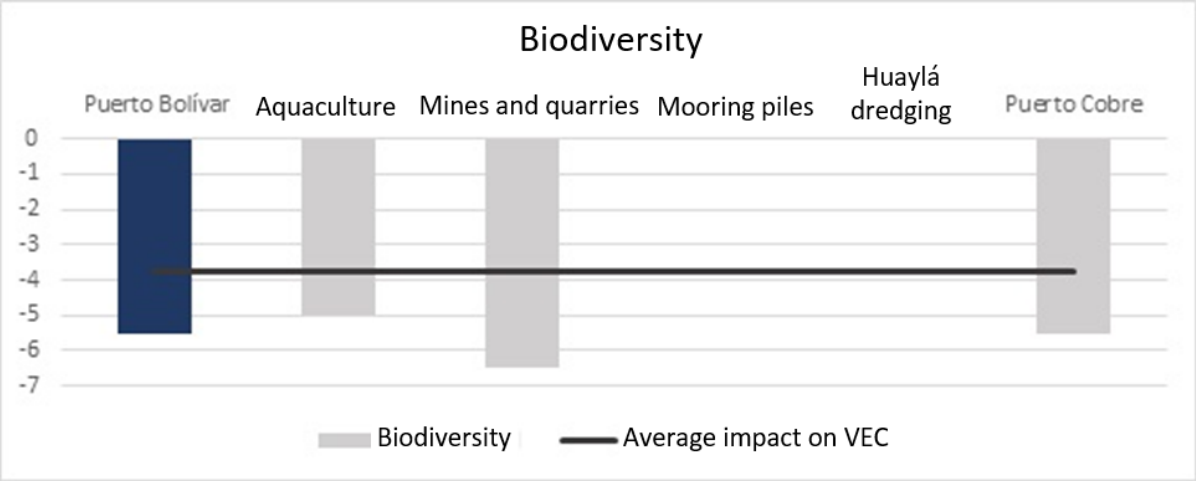


Prepared by: Ecosambito, 2020

Biodiversity

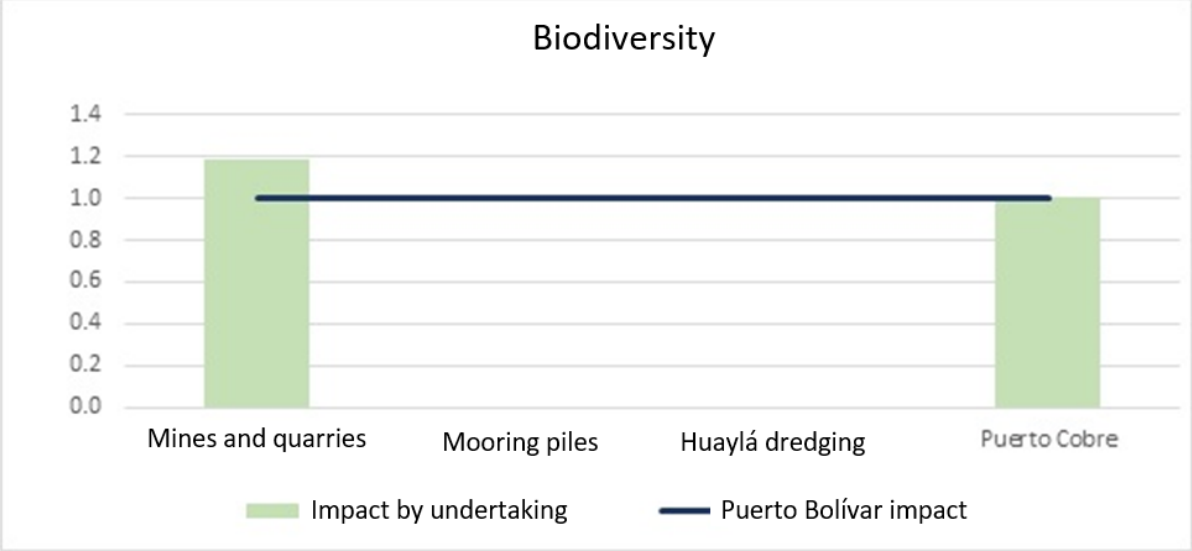
This VEC is negatively affected by all the undertakings described, although to a lesser extent by port activities; however, the magnitude of this effect is still moderate.

Figure 31 Cumulative impacts by undertaking against Average impact on biodiversity



Prepared by: Ecosambito, 2020

Figure 32 Cumulative impacts by undertaking against the Project in relation to Biodiversity

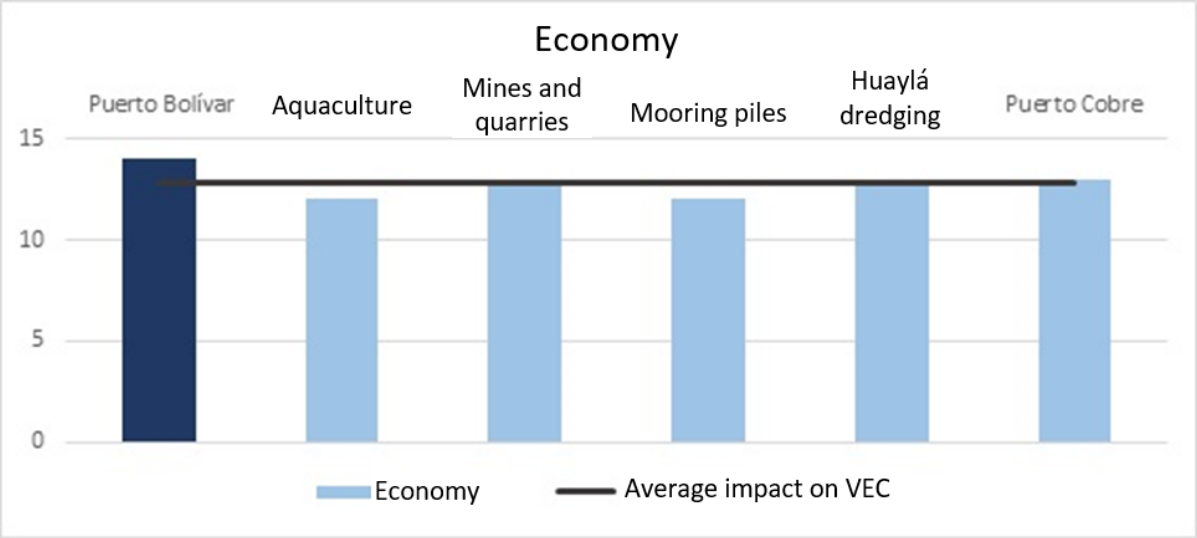


Prepared by: Ecosambito, 2020

Economy

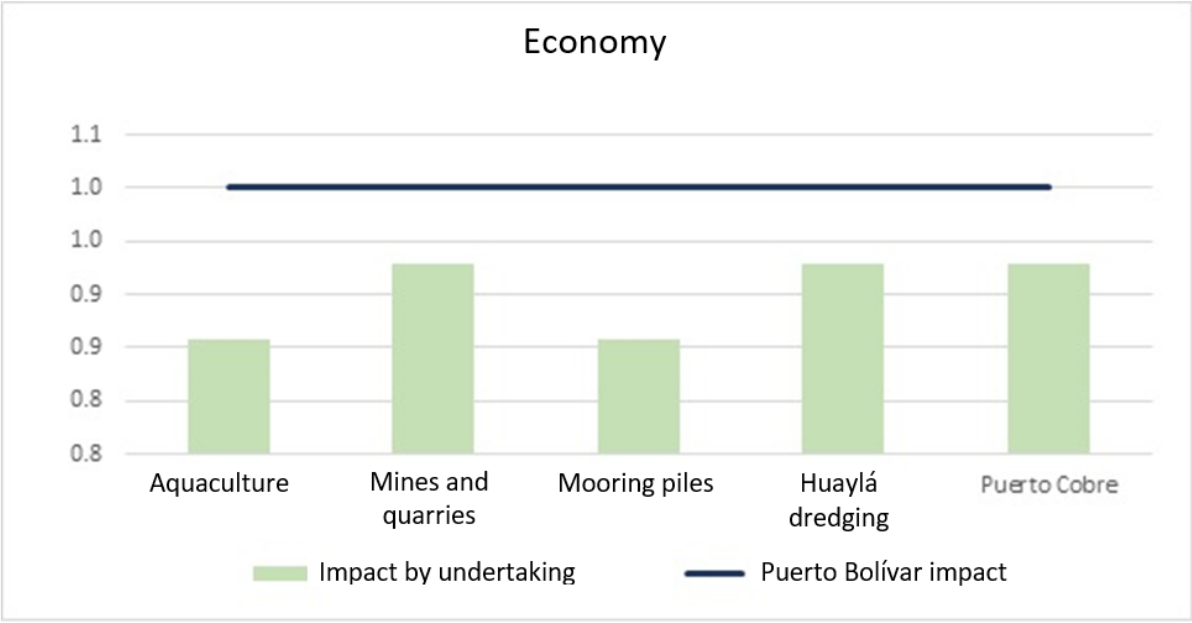
All undertakings make a similar contribution to the economy given their crucial importance in job creation and commerce as the main economic driving force in the region.

Figure 35 Cumulative impacts by undertaking against Average impact on the economy



Prepared by: Ecosambito, 2020

Figure 34 Cumulative impacts by undertaking against the Project in relation to the economy

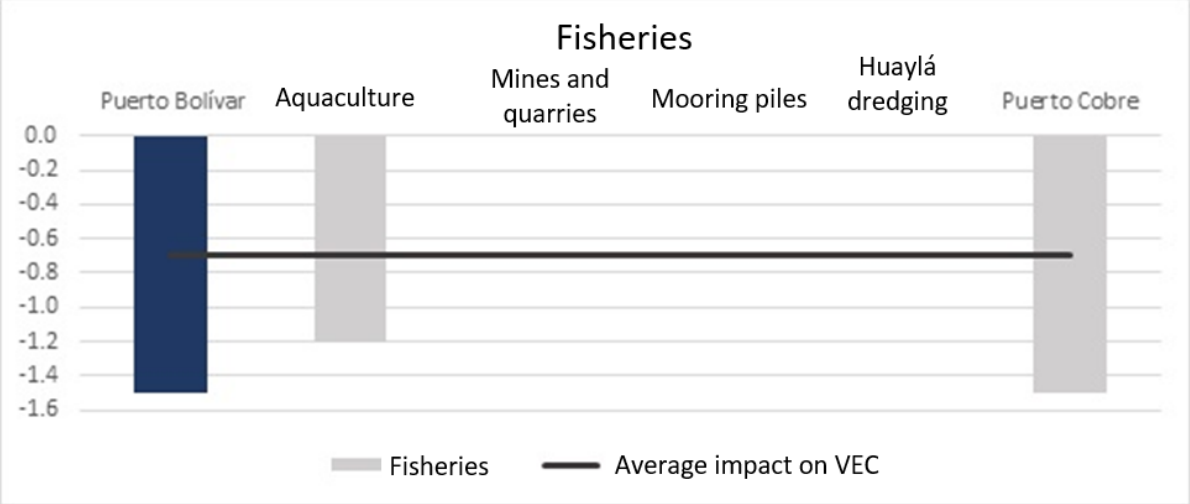


Prepared by: Ecosambito, 2020

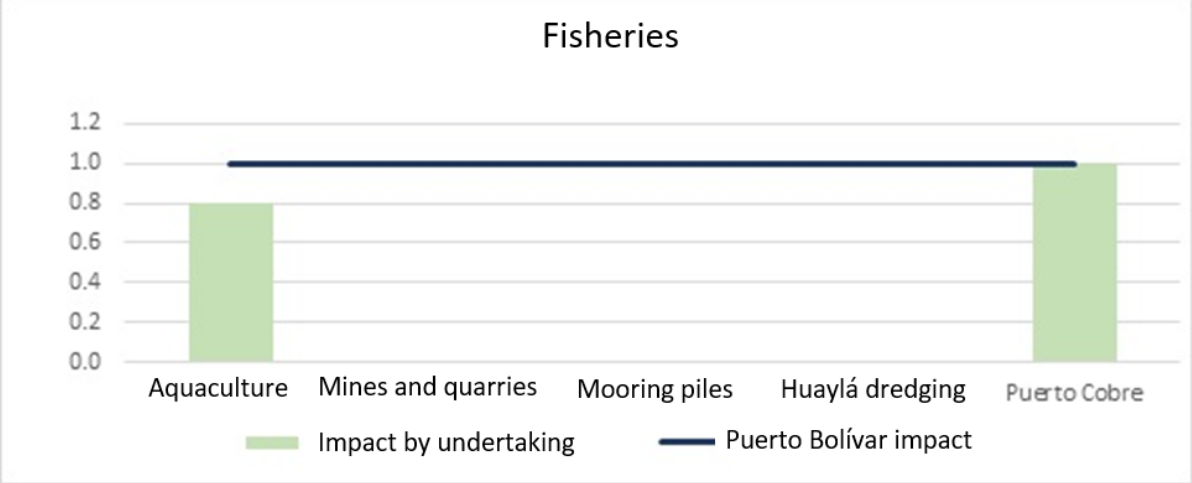
Fisheries

Direct impacts on fisheries receive the lowest negative results compared to other assessed VECs. However, they must be subject to careful inspection, e.g. regarding biodiversity and the quality of their water, given how valuable a resource they are, and of their marine coastal environment.

Figure 35 Cumulative impacts by undertaking against Average impact on fisheries



Prepared by: Ecosambito, 2020



Prepared by: Ecosambito, 2020

11. Management framework for cumulative impacts

An alternative that may improve to some extent the management of cumulative impacts from Puerto Bolívar Expansion Project Stage 1 is to adopt policies related to environmental management legislations which bind the leading company to their suppliers and clients, such as ISO standards, or implement them as requirements for contracting suppliers or services.

Practices to promote

With the aim of encouraging and reinforcing the environmental management culture of the Project and undertakings in the area of influence, especially with those which may relate to Yilportecu, the practices described in Table 18 have been laid down.

Table 18 Cumulative impacts management

VEC	Management action proposed	Goal	Responsible party	Tracking	Indicator	Interaction with other VECs	Observations
Water and sediment quality	Monitoring of water quality in the monitoring points established in Estero Santa Rosa (6 points included in the baseline) and the offshore sediment basin (1 point inside and one outside of the dispersion area) and assessment thereof according to Table 2, Annex 1, Book VI of TULSMA (A.M. 097 – A). -	Monitoring of marsh water quality in order to detect potential effects.	HSE Management	Ministry of Environment and Water of Ecuador (MAAE)	% of performance against forecast	Soil quality/ Biodiversity/ Fisheries/ Economy	Monitoring points are established in the PMA in force.
	Monitoring of soil quality in the monitoring points established in Estero Santa Rosa (6 points included in the baseline) and assessment thereof according to Table 1, Annex 1, Book VI of TULSMA (A.M. 097 – A) and Reference Values of Canadian Environmental Quality.	Monitoring of sediment quality in order to detect potential effects.	HSE Management		% of performance against forecast		Monitoring points are established in the PMA in force.
	Cooperation in the development of joint initiatives for reducing waste discharges to Estero Santa Rosa, alongside fishermen trade unions, residents and public institutions with subject matter jurisdiction (local government and the MAAE). -	Volume reduction of waste discharges near the marsh.	HSE Management/ Projects Department/ Human Resources Department	Management	% of implementation of the developed plan against forecast.		To be developed in the Community Relations Plan of the PMA in force and in Corporate sustainability initiatives.

VEC	Management action proposed	Goal	Responsible party	Tracking	Indicator	Interaction with other VECs	Observations
Soil quality	Inclusion of the following conditions in the terms of reference for service contracting and/or purchase: - The contractor and/or supplier must carry out the collection and management of common and recyclable waste pursuant to Technical Regulation NTE INEN 2841:2014-03. - The contractor and/or supplier must carry out the collection and management of hazardous and special waste pursuant to Ministerial Resolution 061, Art. 93 on sites for hazardous waste storage, and technical regulations INEN 2266 and INEN 2841 where applicable.	Decreasing the production and poor management of common and hazardous waste.	HSE Management/ Projects Department/ Legal Department/ Purchase Department	Management	% of implementation (number of included suppliers against the total)	Biodiversity/ Fisheries/ Economy	
	Inclusion in the Supplier Audit criteria of the verification of compliance with the conditions described in their facilities within the Port Terminal and in the Project area of influence. -		HSE Management		Supplier Evaluation Statistics.		

VEC	Management action proposed	Goal	Responsible party	Tracking	Indicator	Interaction with other VECs	Observations
Maritime traffic	Implementation and extension to contractors and/or service suppliers of the adoption of "Practice guidelines for the avoidance of collisions with whales or other marine mammals" should they occur. A report format must be included in every occasion this measure is implemented. - Implementation and extension to contractors and/or service suppliers of the adoption of Response guidelines in the event of marine mammal stranding, should they occur. A report format must be included in every occasion this measure is implemented. -	Appropriate response and monitoring in case marine fauna is affected.	HSE Management/ Projects Department/ Legal Department/ Operations Department	Management/ Projects Department	% of implementation (number of included suppliers against the total)	Biodiversity/ Fisheries/ Economy	Measure included within the PMA in force. Existing guidelines under review.
Biodiversity	Monitoring of main marine ecosystems: plankton, nekton and benthos, fishery productivity and description of activities of protected marine fauna, in the monitoring stations established in the PMA in force. -	Characterization of the conditions of main marine ecosystems, fishery productivity and protected marine fauna.	HSE Management	Ministry of Environment and Water of Ecuador (MAAE)	Biological diversity and richness. Biological descriptors	Fisheries/ Economy	Monitoring points are established in the PMA in force.

VEC	Management action proposed	Goal	Responsible party	Tracking	Indicator	Interaction with other VECs	Observations
	Monitoring of mangrove productivity of mollusks and crustaceans, in the productive areas identified by users (PAP) within the zones with AUSCM in Estero Santa Rosa laid down in the PMA. Inclusion of a compulsory monitoring procedure for identifying and recording fish species in the area, carried out by way of standardized casting nets or other means suitable for the area. -	Characterization and monitoring of mangrove productivity for mollusks and crustaceans.	HSE Management				
	Update on the bioaccumulation analysis of heavy metals in bivalvia (*Anadara Tuberculosa*) at the 4 sites included in this report. -	Characterization of the state of bioaccumulation in fishery resources (PAP).	HSE Management	Management	Conducted assessments		
Economy	--	--	--	--	--	--	--
Fisheries	Implementation and presentation of the Communication Guidelines to fishery organizations as a means for notifying them of potential effects on the fishery activity. -	Timely conveyance of information and avoidance of conflicts with social actors.	Management/ HSE Management/ Projects Department	HSE Management	Communication recording and tracking.	Economy	

VEC	Management action proposed	Goal	Responsible party	Tracking	Indicator	Interaction with other VECs	Observations
	Prior to the commencement of dredging or construction activities, compulsory announcement to public entities with jurisdictional capacity in the areas of influence of the activities to be performed, work schedules and restrictions (if any) with a minimum 1-week notice before the performance of said works. -			Projects Department			

Prepared by: Ecosambito, 2020

12. Bibliographical references

Aguirre-Rubi R., Ortiz Zarragoitia M., Izagirre U., Etxebarria N., Espinoza F. and I. Marigomez (2019) Prospective biomonitor and sentinel bivelve species for pollution monitoring and ecosystem health disturbance assessment in mangrove-lined Nicaraguan coast. Science of the total Environment. 649(2019)186-200.

Banco Central del Ecuador (2021). Reporte de Minería. Resultados al tercer trimestre de 2020.

Brisbois B.W., Spiegel J.M. and L. Harris (2019). Health, environment and colonial legacies: Situating the Science of pesticides, bananas and bodies in Ecuador. Social Science & Medicine. 239 (2019) 11529

Cabrera Morocho (2018). Planteamiento de alternativas ambientales para distintas actividades antropicas realizadas en el estero Huaylá de Puerto Bolívar. Unidad Académica de Ciencias Sociales, Carrera de Gestión Ambiental. Universidad Técnica de Machala.

Cornejo Xavier (2014). En MAE (Ministerio del Ambiente del Ecuador); FAO (Organización de las Naciones Unidas para la Alimentación y la Agricultura, IT). 2014. Árboles y Arbustos de los Manglares del Ecuador. Quito. 48p.

ERF (Environmental Research Foundation) 1991. The false promise of pesticides. Rachel's Hazardous Waste News 247 (August 21).

Franco Garcia Miguel (2014). La contaminación acústica submarina: Especial referencia al impacto sobre los cetaceos producidos por los sonares de delo Buques de Guerra. Actualidd Juridica Ambiental, 17 de marzo del 2014.

García J.E (1997). Consecuencias indeseables de los plaguicidas en el ambiente. Agronomia mesoamericana 8(1): 119-135.

León Pérez M.J (2015). Uso de plaguicidas en producción de arroz de la provincia del Guayas: reducción de costos, rentabilidad económica, disminución del daño al medio ambiente, periodo 2010-2013. Tesis presentada para optar al título de Economista. Facultad de Ciencias Económicas, Universidad de Guayaquil.

López Apolo Miguel (2015) Análisis fisicoquímico de la calidad del agua en el canal El macho de la Ciudad de Machala. Tesis de Grado para optar al título de Ingeniero Químico. Carrera de Ingeniería Química, Universidad Técnica de Machala

Stuart E. Hamilton (2019). Mangroves and Aquaculture, a five-decade remote Sensing Analysis of Ecuador´s Estuarine environments. Coastal Research Library 33. 211 pp. Springer.

Henriquez W., Jeffers R.D., Lacher T. E. and R.J. Kendall (1997). Agrochemical use on banana Plantations in Latin América: Perspectives on Ecological Risk. Environmental Toxicology and Chemistry, Volume 16. N° 1 pp 91-99.

International Finance Corporation-World Bank Group (2015). Manual de Buena Práctica Evaluación y Gestión de Impactos Acumulativos: Guía para el Sector Privado en Mercados Emergentes

Jiménez M., Van Der Veken L., Neirynck H., Rodriguez H, Ruiz O.and R.Swennen (2007). Organic banana production in Ecuador: its implications on black Sigatoka development and plant-soil nutritional status. Renewable Agriculture and food systems: 22(4): 297-306.

Ministerio de Energía y Recursos Naturales No Renovables (s.f). Plan Nacional de Desarrollo del Sector Minero 2020-2030.

Moran Sánchez Sarita (2014). Evaluación técnica y sanitaria del Sistema de camales Municipales de la provincia de El Oro. Tesis presentada como requisito para optar el grado de magister en producción Animal. Facultad de Ciencias Agropecuarias. Centro de PostGrado "Dr Esteban Quirola Figueroa"

Peña-Carpio E. y J.M. Menendez-Aguayo (2016). Environmental study of gold mining tailings in the Ponce henriquez mining área (Ecuador). DYNA Vol(83) N° 185, febrero 2016. Pp 237-245. Universidad Nacional de Colombia, Medellin, Colombia.

Primicias (2020). Productores y exportadores de banano en una nueva disputa de precios. Economía 14 de agosto 2020. Downloaded from https://www.primicias.ec/noticias/economia/productores-exportadores-banano-nueva-disputa-precios/

Purseglove, J.W. 1972. *Tropical Crops: Monocotyledons 2.* John Wiley & Sons, New York, NY, USA.

Roibas L., Elbehri, A. and A. Hospido (2015). Evaluating the suistanability of Ecuadorian Bananas: Carbon Footprint, Water usage and wealth distribution along the supply chain. Sustainable production and comsumption 2. (2015) 3-16.

Romero-Estevez D., Yanez Jacome G., Dazzini langdon M., Simbaña Farinango K., Rebolledo Monsalve E., Duran Cobo G and Hugo Navarrete (2020). An oveview of cadmium, chromium, and lead content in bivalves consumed by the Community of Santa Rosa Island (Ecuador) and its health risk assessment. Frontiers in environmental science doi: 10.3389/fenvs.2020 00134

Russo R.O and C. Hernández (1995). The environmental impact of banana production can be dimished by proper Treatment of wastes. Journal of sustainable agriculture. Vol 5(3) 5-13.

Stephens C.S. 1984. Ecological upset and recuperation of natural control of insect pests in some Costa Rican banana plantations. *Turrialba* 34:101–105.

Tarras-Walbergg N, H., Flachier A., Fredriksson G., Lane S., Lunberg B y O. Sangfors (2000). Environmental Impact of small-scale and Artisanal Gold Mining in Southern Ecuador. Implications for the Setting of Environmantal Standards and for the managament of the small-scale Mining Operations. AMBIO Vol 29. N°8 Dec 2000.

Terchunian, A.,Klemas K., Segovia A ., Alvarez A., Vasconez B. and L. Guerrero (1986). Mangrove Mapping in Ecuador: the impact pf shrimp pond construction. Environmental management Vol 10, N°3 pp 345-350.

Tobar J., Ramirez-Muñoz M, Fermin I y W. Senior (2017). Concentracion de metales Pesados en Bivalvos Anadara tuberculosa y A.similis del estero Huaylá, provincia de El Oro, Ecuador. Boletin del Centro de Investigaciones Biologicas. Vol 51. N°1, Enero -Abril 201. Pp19-30.

Fausto López-Rodríguez, F; Benítez, A; Jurrius, I. (2019). Efectividad del Manejo de Acuerdos de Uso Sustentable y Custodia de Manglar en la provincia de El Oro. Martha Molina Moreira (comp.) Primer Congreso manglares de América, Guayaquil – Ecuador.

Valbuena D.S., Melendez-Florez M.P., Villegas V.E., Sanchez M.C. y M. Rondon-Lagos (2020). Daño celular y genético como determinantes de la toxicidad de los plaguicidas. Ciencia en desarrollo, Vol 11: N°2

Vera, L. (2004). Estudio del nivel medio del mar en Puerto Bolívar. Acta Oceanográfica del Pacifico, 12(1), 2003-2004.

Villalba, H. y V.S Salazar (2016). Factores que determinan la supervivencia de los pacientes intoxicados por Paraquat, estudio realizado en el Centro de Información y Asesoramiento Toxicológico del ministerio de salud Pública de Ecuador, periodo enero 2013 a diciembre 2014. Tesis de grado Facultad de Ciencias Médicas. Especialización en Medicina de Emergencias y Desastres. Pontificia Universidad Católica del Ecuador.

Walker, L.J. and J. Johnston (1999) EC DG XI Environment, Nuclear Safety & Civil Protection Guidelines for the Assessment of Indirect and Cumulative Impacts as well as Impact Interactions. NE80328/D1/3. European Union

Watkins,G., Atkinson, R., Canfied, E., Corrales,D., Dixon, J., Factor, S., Hardner, J., Hausman, H., Hawken, I., Huppman, R., Josse., C., Langstroth, R., Pilla. Ernani., Quintero, J., Radford, G., Rees, C., Rice, D., and A.Villalba (2015). Guia para evaluar y gestionar los impactos y riesgos para la biodiversidad en los proyectos respaldadps por el Banco Interamericano de Desarrollo. Downloaded from http://www.iadb.org.

Zambrano,M., Prada J., Arencibia G. y A. Vidal (2012). Bioacumulación de naftaleno y fluoranteno en el molusco bivalvo *Anadara tuberculosa* (Sowerby, 1833). Ciencias de la salud, Revista U.D.C.A Actualidad y divulgacion científica de la Universidad de Ciencias aplicadas ambientales.

Capa, L., Sotomayor, J., Vega, F. La Provincia de El Oro: algunas consideraciones de los sectores productivos y empresariales (2017). Revista Redes 2017. *Editorial UTMACHA*

13. Annexes

I, Miguel Angel Pantoja Shimanskii, certify that the present document consisting of 80 pages in english was translated from its original version in spanish, it's accurate to the best of my capacities as a Sworn Court Certified Translator of the Judicial Council of Ecuador.

Yo, Miguel Angel Pantoja Shimanskii certifico que el presente documento que consta de 80 páginas en ingles fueron traducidas de su versión original en español, son precisas en mis capacidades como traductor calificado y jurado del Consejo de la Judicatura.

Nombre/ Name: Miguel Angel Pantoja Shimanskii
CC/National ID #:1717206534

Fecha/Date: 2 de Junio 2021 / June 2, 2021
Número de calificación/ Qualification number: 1840315
Correo electrónico/email: m.pantoja@translatorsecuador.com
Tel: +593. 999946572

Note/Nota: You can verify credentials inputting National ID# on the following link:

Verifique las credenciales ingresando la CC en el siguiente link:
https://appsj.funcionjudicial.gob.ec/perito-web/pages/peritos_nacional.jsf