ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT METHODOLOGY

The general methodology adopted by Golder for Environmental and Social Impact Assessment Studies has been designed to be analytical and transparent and allow a semi-quantitative analysis of the impacts on the various environmental and social components. The methodology is based on the premise that projects can generate both negative and positive impacts with a magnitude that can be evaluated by considering several attributes of the project activities and of the receiving environment.

The methodology is based on three main building blocks and on the identification, description and quantification of the following key elements:

- **Project actions:** activities directly or indirectly related to the project which can interfere with the environment as primary generative elements of environmental or social pressures;
- **Impact factors**: direct or indirect interferences produced by the project actions on the environment, able to influence the state or quality of one or more environmental and social components;
- **Sensitivity of the component**: sum of the conditions which characterize the present quality and/or trends of a specific environmental and social component and/or of its resources;
- **Impacts**: changes undergone by the environmental state or quality because of the effects caused by the impact factors on the environmental or social component;
- **Mitigation measures**: actions adopted to mitigate negative impacts or to improve the effects of positive impacts on the environmental and social component.

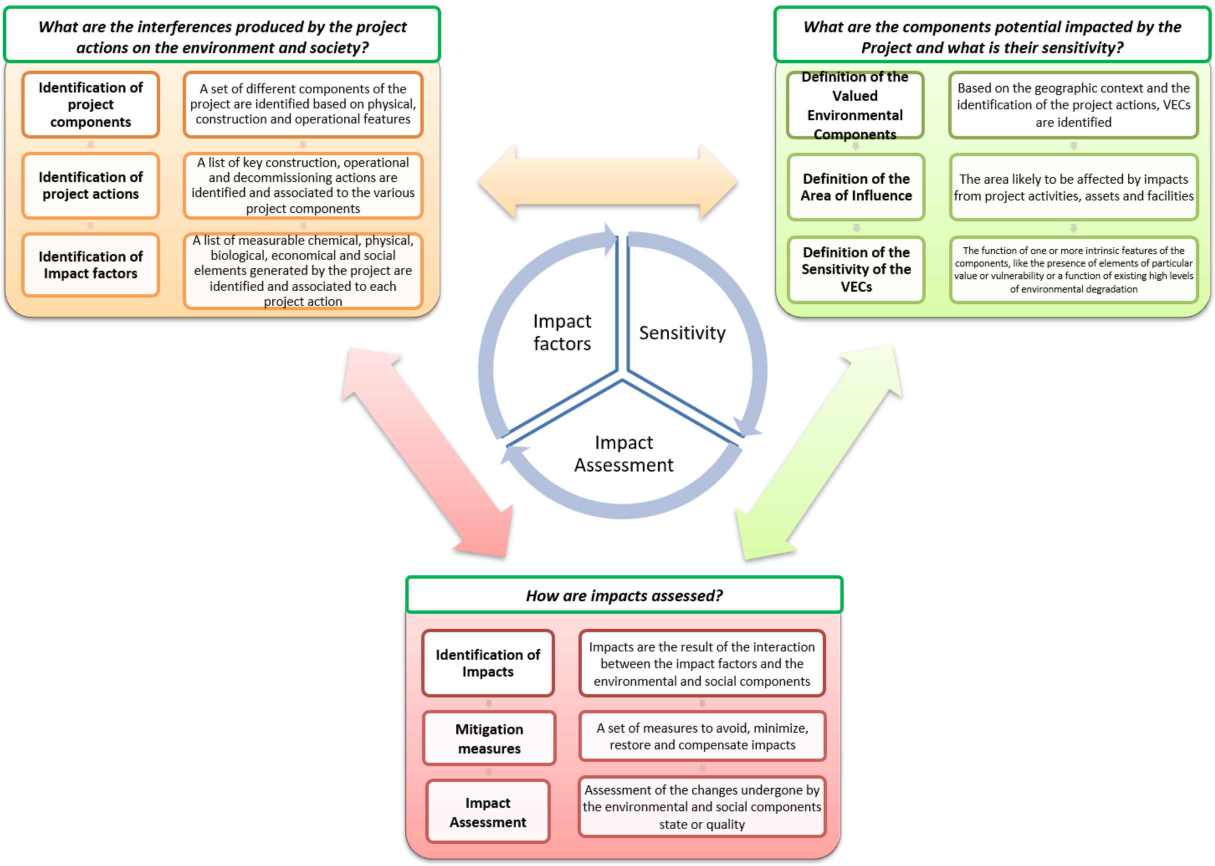

Figure 1 Three building blocks of the ESIA methodology

<u>Identification of the project components</u>

Project components are identified coherently with the definition of the IFC PS1 as follows:

- The project and the client's activities and facilities that are directly owned, operated or managed (including by contractors) and that are an essential component of the project;
- Unplanned but predictable developments caused by the project that may occur later or at a different location; and
- Associated facilities, which are facilities that are not funded as part of the project and that would not have been constructed or expanded if the project did not exist and without which the project would not be viable.

Identification of the project actions

Project actions are activities directly or indirectly related to the project which can interfere with the environment as primary generative elements of environmental or social pressures, defined in the context of this methodology as impact factors. Project actions for typical greenfield infrastructure projects might include the following:

- **Land acquisition**: includes all necessary administrative and field activities that allow the project proponents to enter in possession of the Project areas
- **Resettlement and livelihood restoration**: includes all the activities to ensure that affected populations are resettled in adequate areas and their livelihood is maintained or enhanced
- **Vegetation clearing**: includes removal of natural vegetation, particularly trees and shrubs to allow excavators and dozers to enter the work areas and other project areas
- **Topsoil/soil removal and storage**: includes stripping of the first layers of vegetated topsoil (including the herbaceous vegetation) for storage on dedicated areas and all actions to prevent soil degradation like water runoff and wind erosion
- **Site levelling and grading**: includes excavation and earthwork to create the surface over which the project will be constructed, and it can include excavation through soft soil, excavation through rocks and excavation through sediments
- **Water diversion and dewatering**: water diversion and dewatering might be necessary to allow construction of foundations or structures in areas of high groundwater level, wetlands and river crossings. It includes various techniques like sheet piling, cofferdams, etc., and eventually pumping of the water.
- **Material transportation**: includes transportation of the project elements and construction material to the stock yards and camps and from the stockyards/camps to the working or construction areas.
- **Material storage**: includes temporary storage of the project elements or other construction materials in stock yards.
- **General engineering/construction works**: includes earthworks (excavation, levelling, grading), laying of concrete foundations, erection of buildings and infrastructures, electrical, hydraulic, telecommunication systems, etc.
- **Bio restoration works**: bio restoration works include reinstating the topsoil, seeding, planning and eventual placement of protective layers (like jute mats) or construction of riverbank protection, slope breakers, etc.

- **Building/infrastructure demolition**: includes demolition of existing structures like buildings, roads, culverts, etc.
- **Accommodation and management of workforce**: includes all activities and services relating to the accommodation of workers at camps including bedding, catering, management of free time, and all the administrative and management activities to ensure full respect of workers' rights and duties.
- **Procurement**: includes all activities relating to the purchase of goods and services that are necessary for the construction and operation of the pipeline system.
- **Plant/infrastructure operation**: includes technical (operation of the plant/infrastructure, surveillance, monitoring, maintenance) and administrative activities to maintain the project in operation according to standard operating procedures

<u>Identification and evaluation of the relevance of the impact factors</u>

The list below presents typical impact factors related to infrastructure projects:

- Emission of greenhouse gases
- Emission of ozone depleting substances
- Emission of dust and particulate matter
- Emission of gaseous pollutants
- Changes to the local morphology
- Removal of topsoil
- Demand for freshwater
- Demand for potable water
- Discharge of wastewater
- Changes in flow/circulation in natural water bodies
- Changes in sedimentation patterns
- Emission of noise
- Emission of vibrations
- Introduction of new buildings/infrastructures
- Removal of buildings/infrastructures
- Demand for waste disposal services
- Demand for industrial minerals (sand, gravel, etc.)
- Removal of natural vegetation
- Introduction of alien species
- Change in land use
- Demand for workforce

- Demand for goods, materials and services
- Demand for energy
- Increase and modification of traffic
- Interruption/limitation of infrastructures/services
- In migration of workers and other people
- Relocation
- Site restoration

For each project the list of impact factors is checked for relevance to the project and eventually extended as a result of the analysis of the project.

The **impact factors** identified during the analysis of the project and through the definition of the project phases and project actions are assessed in their relevance, using a scoring system. The parameters considered to assess the impact factor score are the following:

Duration (D): is the duration of the impact factor and can vary from short to long according to the following definitions:

- very short, when the duration is shorter than a month;
- short when the duration is between a month and one year;
- medium when the duration is between one and two years;
- long when the duration is between two and five years;
- very long when the duration is over five year.

Frequency (F): is the frequency with which the impact factor manifests itself:

- single event;
- infrequent, if it consists of a few events evenly or randomly distributed over time;
- recurrent, if it consists of numerous events evenly or randomly distributed over time;
- frequent if it consists of a high number of events evenly or randomly distributed over time;
- continuous, if the event has no interruption over time.

Geographic extent (G): is the geographical area within which the impact factor can exert its effects:

- project site; the impact factor is confined within the facilities owned or exclusively controlled by the project;
- local; the impact factor extends to the areas or communities neighboring the project site
- regional; the impact factor extends to an area beyond the surroundings of the project site and to regional physical (airshed – watershed, etc) or administrative boundaries
- national; the impact factor extends throughout several regions or to the entire country
- international: the impact factor has an international or global reach

Intensity (I): is a measure of the physical, economic or social severity of the impact factor:

- negligible: the impact factor is generated in quantities that cannot be easily detected or perceived and that are unlikely to be able to cause any detectable change in the target environmental or social components;
- low: the impact factor is generated in quantities that can be detected or perceived but whose effects are unlikely to cause tangible changes in the target environmental or social components;
- medium, the impact factor is generated in quantities that are well within legal standards or accepted practices and/or whose effects are likely to cause tangible changes in the target environmental or social components;
- high, the impact factor is generated in quantities that at the limit of legal standards or accepted practices and/or whose effects are likely to cause serious impairment in the target environmental or social components;
- very high, the impact factor is generated in quantities that are at risk of exceeding the limits of legal standards or accepted practices and/or whose effects are likely to cause very serious to catastrophic damage to the target environmental or social components;

Each of the parameters listed above can have a value between 1 and 5, and severity of the impact is determined through an **Impact Factor Score** which is the sum of the 4 parameters, hence it can assume a value between 5 and 20.

Definition of the sensitivity of the environmental and social components

Each environmental and social component in the area of influence of the project has a different sensitivity to the impact factors generated by the project or can pose a different level of risk to the project. The sensitivity of an environmental component is typically evaluated on the basis of the presence/absence of some features which define both the current degree of the environmental quality and the susceptibility to environmental changes of the component. As examples, for physical components the sensitivity is typically related to the presence of elements that are at the highest or lowest scale of quality, for biodiversity it is related to the presence of threatened, endemic, or protected species or habitats and for social components to the presence of vulnerable elements of the community like poor, elderly, members of ethnic or religious minorities, indigenous people, etc. The sensitivity (S) of the component is defined using component specific-metrics during the baseline and can assume values between 1 and 5.

The following list presents potential features to be considered in defining the sensitivity of typical environmental and social components considered in ESIA studies. The specific metrics and levels of sensitivity for each of the features considered is defined during the baseline studies specifically for the project.

Geology and geomorphology:

- Presence of faults: areas with active faults are considered to pose highest risks to the project and hence are considered of higher sensitivity;
- Presence of landslides: areas within the range of landslides are considered to pose highest risks to the project and hence are considered of higher sensitivity;
- Other geohazards: (karst areas, slope erosion, liquefaction, stream channels, etc.). the presence of other geohazards in the project area is considered of higher sensitivity;
- Seismicity: the location of the project in areas classified as at seismic risk is considered of higher sensitivity

Soils:

- Soil agricultural potential: soils with highest agricultural potential according to local or global assessments are attributed a higher sensitivity
- Soil erosion potential: soils with highest erosion potential according to local or global assessments are attributed a higher sensitivity
- Soil pollution potential: soils in areas identified and previously used for industrial, mining, or intensive agriculture are attributed a higher sensitivity.

Surface water

- Presence of waterbodies in the project area of influence and level of ecological integrity; the sensitivity increases with the level of ecological integrity;
- Presence of waterbodies in the project area of influence and level of water/sediment pollution; the sensitivity increases in the presence of polluted watercourse;
- Presence of waterbodies and level of tolerance to hydrological changes; the sensitivity is higher for waterbodies with a low level of tolerance for hydrological changes;

Groundwater

- Presence of shallow aquifers; the sensitivity increases with the presence of shallow aquifers that could be more easily exposed to contamination source;
- Productivity of exploited aquifers; aquifers with low productivity might be depleted in case the project entails groundwater abstraction. The sensitivity is higher for aquifer with low productivity;
- Presence and extent of existing groundwater exploitation; the sensitivity is higher for aquifers already exploited;
- Rock permeability; the sensitivity increases in case the subsoil is made of rocks with high permeability.
- Aquifer vulnerability; the sensitivity increases with the vulnerability of the aquifer as determined by accepted methodologies;

Landscape and visual quality:

- Presence and number of settlements/people within the visual zone of visual influence;
- Presence of areas of touristic interest within the visual zone of visual influence;
- Presence of roads and volume of traffic within the visual zone of visual influence;
- Presence of archaeological, cultural, historic areas within the visual zone of visual influence;
- Presence of natural parks protected and classified areas within the visual zone of visual influence;

Climate

- The project area is characterized by an extreme climate (semi-desert, circum arctic, etc.) and/or by a frequency of extreme events (tornadoes, floods, droughts, etc.).
- There is evidence of the effects of climate change within the project area of influence.
- The project area has a limited ability to adjust to climate change.

Air quality

- Presence of settlements and population potentially exposed to air emissions from the project; the sensitivity increases with the number of people exposed;
- Presence of vulnerable targets (schools, hospitals, retirement houses, etc.) exposed to air emissions from the project; the sensitivity increases with the number of vulnerable people exposed;
- Air quality levels in the areas affected by the project; the sensitivity increases in areas already polluted and in areas designated for air quality protection;
- Presence of sensitive ecological receptors like protected or classified areas, protected or endangered habitats and species;

Noise and vibration:

- Presence of settlements and population potentially exposed to noise and vibration from the project; the sensitivity increases with the number of people exposed;
- Presence of vulnerable targets (schools, hospitals, retirement houses, etc.) exposed to noise and vibration from the project; the sensitivity increases with the number of vulnerable people exposed;
- Noise and vibration levels and/or sources in the areas affected by the project; the sensitivity increases in areas already experiencing high levels of noise and vibrations and in areas designated for protection from noise and vibrations;
- Presence of sensitive ecological receptors like protected or classified areas, protected or endangered habitats and species;

Marine Sediment

- Presence of fine sediment (due to the fine sediment contaminants sorption); areas with sediment contamination level above the thresholds.

Marine water quality

- Zones with limited circulation and water mass exchange; zones with wide sectors with limited bathymetric range; zones with water contamination level above the thresholds.

Marine acoustic climate

- Areas not affected by noise generated by artificial sources and areas known to be important for cetaceans and ecologically significant for the marine fauna in general.

Flora

- Number of species of flora present in the project area of influence. The sensitivity increases with the number of species present.
- Presence of threatened species of flora in the project area of influence as defined by global (IUCN) or national red lists. The sensitivity increases with the number of threatened species present and the level of threat.
- Presence of endemic or restricted range species of flora in the project area of influence as defined by global (IUCN) or national red lists. The sensitivity increases with the number of species present and the level of endemicity.

- Presence of protected species or species listed in international conventions for the protection of biodiversity. The sensitivity increases with the number of protected/listed species.
- Presence of invasive alien species. The sensitivity is higher in areas with a higher number of invasive alien species.

Fauna

- Number of species of fauna present in the project area of influence. The sensitivity increases with the number of species present
- Presence of threatened species of fauna in the project area of influence as defined by global (IUCN) or national red lists. The sensitivity increases with the number of threatened species present and the level of threat.
- Presence of endemic or restricted range species of fauna in the project area of influence as defined by global (IUCN) or national red lists. The sensitivity increases with the number of species present and the level of endemicity.
- Presence of protected species or species listed in international conventions for the protection of biodiversity. The sensitivity increases with the number of protected/listed species.
- Presence of invasive alien species. The sensitivity is higher in areas with a higher number of invasive alien species.

Habitats

- Presence of natural habitats; the sensitivity increases with the surface of natural habitats present in the project area of influence.
- Presence of threatened or protected habitats; the sensitivity increases with the surface of threatened or protected habitats present in the project area of influence.
- Presence of critical habitats; the sensitivity increases with the surface of critical habitats present in the project area of influence.

Protected areas

- Presence of protected areas; the sensitivity increases with the number, extent and level of protection of protected areas present in the project area of influence.

Economy

- Presence of skilled personnel; positive economic impact due to employment depends on the presence in the local workforce of the skills that are most relevant to the project. The sensitivity is higher for communities with skilled personnel.
- Presence of businesses and economic activities relevant to the project; positive economic impact due to procurement of goods and services depends on the presence of economic activities in the local communities. The sensitivity is higher for communities with a well-structured business community.

Employment and livelihood

- Level of employment (for men, women, youth) compared to National – Regional average
- Level of household income compared to National – Regional average

Education

- Presence of education facilities;
- Level of education of the population;

Health

- Level of health care available; the project could cause a population influx that can put a strain to existing health services if left unmanaged. The sensitivity is higher in areas with an insufficient level of healthcare available;
- Presence of communicable diseases; the spreading of communicable diseases can be exacerbated by the influx of workers due to the project. The sensitivity is higher in areas affected by a high level of communicable diseases.
- Overall health state of the population; the project might cause increased levels of exposure to environmental health determinants like air pollutants, noise and vibrations, etc. The sensitivity is higher in the presence of existing health issues in the communities potentially affected by the project.
- Presence of existing environmental health determinants. The presence of environmental health determinants like air and water pollution, soil and groundwater contamination is increasing the sensitivity.

Social capital

- Presence of Non-Governmental Organizations and Community Based Organizations.
- Presence of formal and informal social networks
- Level of social conflict in the communities

Politics and governance

- Presence and role of government institutions
- Presence of local elected officials
- Level of political participation
- Presence of multiple political parties
- Presence and severity of political conflicts

Land and properties

- Presence of agricultural land:
- Presence of houses;
- Presence of public buildings

Community safety and security

- Crime rate in the communities
- Effectiveness of the law enforcement system
- Effectiveness of the judiciary system

Transportation and traffic

- Presence and state of transportation facilities (roads, railways, ferry, etc)
- Presence and level of service of public transportation
- Presence of traffic congestion issues

Infrastructures

- Presence of transportation infrastructures
- Presence of energy infrastructures
- Presence of water infrastructures

Ecosystem Services

- Presence of ecosystem services;
- Dependence of the local communities from ecosystem services

Cultural heritage:

- Presence of protected or recognized sites of archaeological or cultural value; the sensitivity increases with the number, cultural/scientific value and level of protection of sites potentially affected;
- Presence of sites with a high archaeological potential in the absence of specific site information or appropriate protection mechanisms; the sensitivity increases with the archaeological potential as indicated by relevant experts;
- Presence of intangible cultural values like sacred sites, initiation sites, sites used for cultural events, sites recognized in oral traditions, etc. the sensitivity increase with the number of sites and values as recognized by the local communities

Identification of the impacts

Impacts are identified as potential interferences of the impact factors with the environmental components identified in the project area of influence. The analysis is conducted by means of matrices where environmental components are listed as rows and impact factors as columns. An example of a simple matrix is presented below.

Impact factor / Component	Emission of dust	Discharge of wastewater	Changes of morphology	Introduction of buildings / infrastructures	Increase of traffic	Topsoil removal
Soil		√	√	√		√
Air quality	√				√	
Surface water quality	√	√				√
Landscape and visual aesthetic			√	√	√	√

When an impact factor has a potential to alter an environmental and social component an impact is identified in the matrix. Impact factors can have a direct or indirect impact over a certain component; as an example, air pollution can cause acidification of the atmosphere that through acid rains can have effects over the vegetation or water quality in exposed waterbodies and finally on biodiversity and communities.

All direct and indirect impacts identified are described in terms of their mechanism of action and likely consequences.

Calculation of the Impact Value

The calculation of the **Impact Value** is done by multiplying the Impact Factor Score for the value of the sensitivity of the target component, determined during the baseline. The result is then corrected by considering the reversibility of the impact.

The reversibility is the property of an impact to diminish its magnitude over time and to eventually recede entirely. The definitions ;

- reversible in the short term if the initial condition of the component will be restored in a period between weeks and months after the end of the impact factor and/or the restoration activities;
- reversible in the short/mid term if the initial condition of the component will be restored in a period between a few months and one year after the end of the impact factor and/or the restoration activities;
- reversible in the mid term if the initial condition of the component will be restored in a period between one year and five years after the end of the impact factor and/or the restoration activities;
- reversible in the long term if the initial condition of the component will be restored in a period between five and 25 years after the end of the impact factor and/or the restoration activities;
- irreversible, if it is not possible to predict the restoration of the initial conditions.

The reversibility is measured on a scale 1 -5 .

The **Impact Value (IV)** is calculated by multiplying the Impact Factor Score + the Sensitivity and by the value of the Reversibility IV= IFS x S x R

Calculation of the Residual Impact

The third step consist in assessing the effectiveness of the mitigation measures to reduce or eliminate the negative impact. The mitigation measures should be defined with reference to the mitigation hierarchy and be organized in a logical sequence of measures to:

- Avoid
- Minimize
- Restore
- Compensate

The effectiveness of the mitigation measures defined in the environmental and social management plan should assessed using expert judgement and the findings from the previous application of the measures to similar projects. The definitions of the mitigation effectiveness are:

- Low: the measures can reduce the impacts by less than 20% of the expected magnitude
- Medium low. the measures can reduce the impacts by 20% - 40% of the expected magnitude
- Medium: the measures can reduce the impacts by 40% - 60% of the expected magnitude
- Medium high: the measures can reduce the impacts by 60% - 80% of the expected magnitude
- High: the measures can reduce the impacts by more than 80% of the expected magnitude

The Mitigation effectiveness is measured on a scale 1 – 0,2 (1=minimum effectiveness; 0,2=maximum effectiveness).

Positive impacts are typically associated to economic and social opportunities and sometimes to environmental aspects particularly in projects located in brownfields where the project can address existing environmental issues. Projects are typically promoting activities to enhance the economic, social and environmental opportunities by means of specific programs, plans and measures including for example skill creation, community investment, shared value programs, remediation programs, biodiversity conservation projects etc.

The assessment of positive impacts is based on the same parameters of the assessment of the negative impacts, with the only difference that the mitigation measures are replaced by enhancement measures, or measures to maximize the potential positive impacts.

The effectiveness of the enhancement measures defined in the environmental and social management plan should be assessed using expert judgement and the findings from the previous application of the measures to similar projects. The definitions of the enhancement effectiveness are:

- Low: the measures can enhance the positive impacts by less than 10% of the expected magnitude
- Medium low. the measures can enhance the positive impacts by 10% - 20% of the expected magnitude
- Medium: the measures can enhance the positive impacts by 20% - 30% of the expected magnitude
- Medium high: the measures can enhance the positive the impacts by 30% - 40% of the expected magnitude
- High: the measures can enhance the positive impacts by more than 40% of the expected magnitude

All mitigation and enhancement measures identified are the basis for the preparation of the environmental and social management plan, where the responsibilities, timelines and costs for their implementations are described.

<u>Scale of residual impacts</u>

The scale of the residual impact resulting from the calculation described above ranges from 0,8 to 500. The impact value is then scaled in 5 levels by diving the entire distribution of values obtained in 5 classes with an equal number of values.

The residual negative impacts are classified in 5 levels using the table below.

Residual impact score	Residual impact definition	
0,8 - 33,0	Negligible	
33,1 - 76,0	Low	

76,1 - 136,0	Medium	
136,1 - 228,0	High	
228,1 - 500,0	Very High	

The residual positive impacts are classified in 5 levels using the table below.

Residual impact score	Residual impact definition	
0,8 - 33,0	Negligible	
33,1 - 76,0	Low	
76,1 - 136,0	Medium	
136,1 - 228,0	High	
228,1 - 500,0	Very High	

Overall assessment

The methodology described above allows for an analytical assessment of impacts caused by individual impact factors over individual components. The process therefore ends with a table presenting for each component several impacts from different impact factors. The assessor has then the possibility to present an overall assessment of the impacts over a certain component, based on expert judgement, and to present the rationale for the overall assessment.

Impacts are presented in separate tables for negative and positive impacts to avoid automatic trade offs and/or mediating between positive and negative aspects, as they are often targeting different sections of the community.

Cumulative Impact Assessment

The environmental and social assessment will consider the cumulative impacts assessments which is defined as the "*cumulative impacts that result from the incremental impact, on areas or resources used or directly impacted by the project, from other existing, planned or reasonably defined developments at the time the risks and impacts identification process is conducted*" according to IFC Performance Standard 1.