

ENVIRONMENTAL IMPACT STUDY FOR THE DOUBLE LANE RUMICHACA – PASTO HIGHWAY PROJECT, PEDREGAL – CATAMBUCO SECTOR, FU 4 AND FU 5,1, CONCESSION CONTRACT UNDER PPA SCHEME N°. 15 OF 2015



Géminis Environmental Consultants Consultores Ambientales





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SECTOR, FU 4 AND FU 5,1, CONCESSION CONTRACT UNDER PPA SCHEME N°. 15 OF 2015

Chapter 4. Area of Influence

San Juan de Pasto, March 2017


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4. AREA OF INFLUENCE

The area of influence, for the double lane highway running from Rumichaca to Pasto, for the sector running from Pedregal to Catambuco, was defined based on project’s technical characteristics as well as on the environmental and social characteristics of the zone. The definition of the area of influence contemplated, among others, impacts that could be generated under biotic, non-biotic and socio-economic medias arising from inherent activities of Project execution.

4.1. Technical Considerations

Technical considerations that were established as parameters for the definition, identification and delimitation of project’s area of influence, are based on concepts of media and component, determined by the Terms of Reference for the formulation of Environmental Impact Studies for the construction of tunnels and highways (Resolution 751 of 2015 issued by the Ministry for the Environment and Sustainable Development –MADS)

Based on the former proviso, the following methodology was established to undertake the final identification of area of influence of the project, both physical as biotic, as well as socio-economic.

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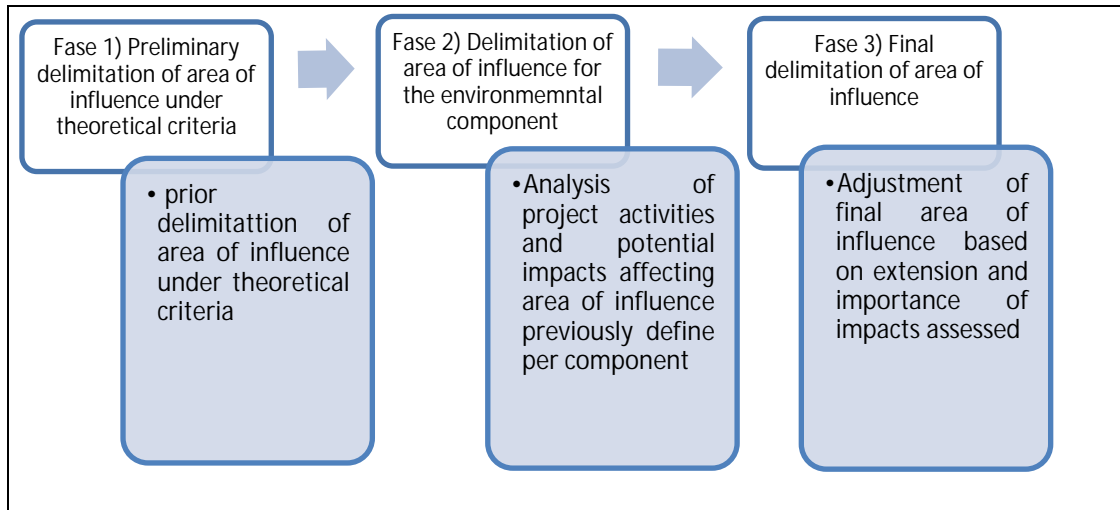



FIGURE 4.1 METHODOLOGICAL MODEL TO DEFINE THE AREAS OF INFLUENCE

Source (Géminis Consultores Ambientales, 2016)

1

As for the cartographic model used to obtain the final areas of influence, physical, biotic, non-biotic and socio economic, an overlaying of different layers at 1:100.000 scale was utilized for preliminary areas and 1:25.000 scale for intermediate and final layers; taking into account the impact evaluation over intermediate areas according to the methodology defined. See Figure 4.1.

For the Physical-Biotic area of influence, the following cartographic model was utilized. Figure 4.2

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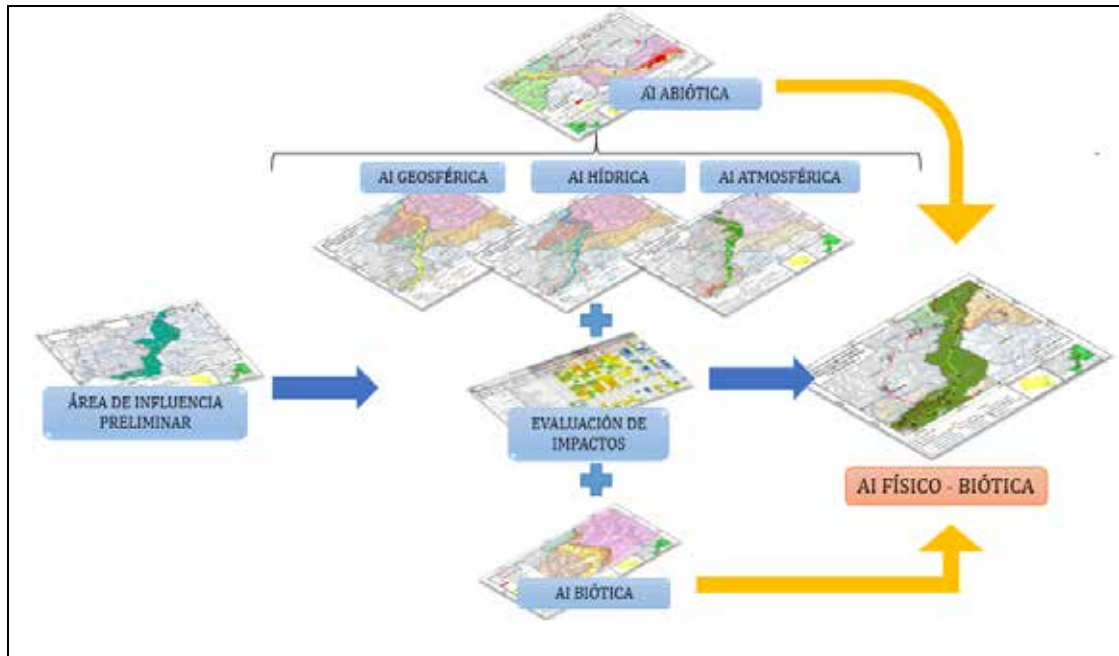



FIGURE 4.2 CARTOGRAPHIC MODEL FOR THE PHYSICAL-BIOTIC AREA OF INFLUENCE

Source (Géminis Consultores Ambientales, 2016)

The cartographic model chosen for the Social-Economic media was much more simple, given that the criteria in place for the determination of the area of influence was one of policy-organizational, added to the evaluation of environmental impacts, as can be seen on Figure 4.3

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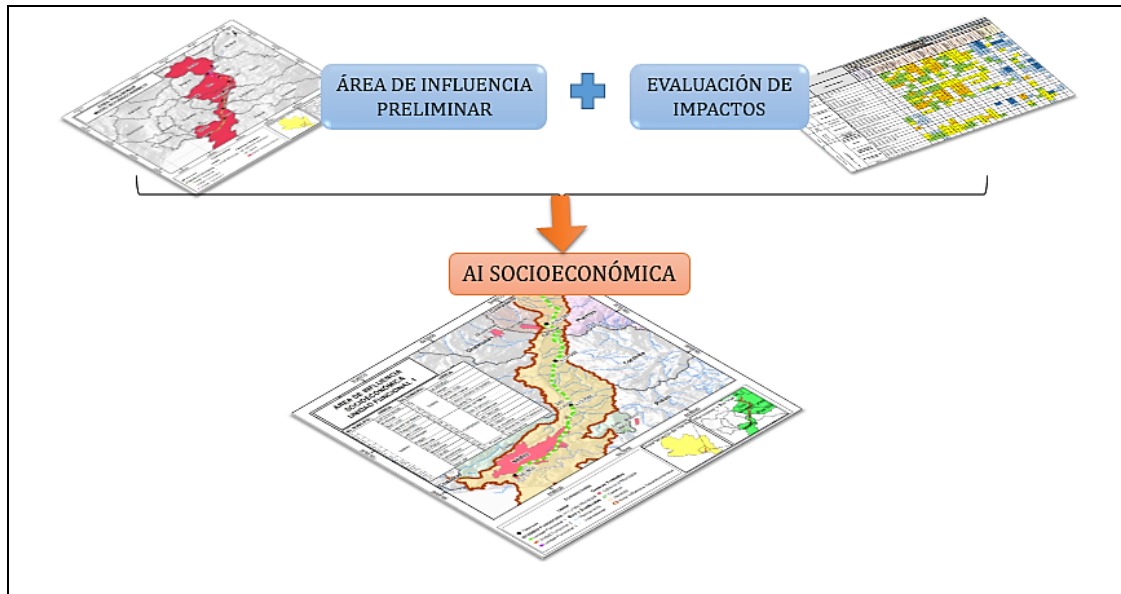



FIGURE 4.3 CARTOGRAPHIC MODEL FOR THE SOCIAL-ECONOMIC AREA OF INFLUENCE

Source (Géminis Consultores Ambientales, 2016)

Technical Aspects

The definition of the Area of Influence was determined based on social and environmental criteria, associated to construction activities of the project, which take place in the area where the highway construction project intervenes. The area of influence for this project, as it is defined, takes into account the delimitation parameters conformed by the chamfer line, as it is given in the design, the extension of the road and the refurbishing of access facilities. In addition to the former, infrastructure associated to the project was also contemplated including Camp Sites and a dumping zone for Debris, Rubble and Excavation Material –ZODME, with their

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corresponding access roads. The description of these areas is presented in Numeral 4.2.5 of this Chapter.

Socio-Environmental Aspects

In order to environmentally and socially characterize the double lane Rumichaca – Pasto highway project, Pedregal – Catambuco sector, for components of each media, an area of influence was established and defined as the area where significant environmental impacts could manifest generated by project execution. These impacts are identified, quantified and described in Chapter 8 of this document (Environmental Assessment), however, in describing each area, only those impacts that were considered in the assessment are presented.

To delimit the area of influence, a preliminary identification was carried out for each area based on the media, performing an analysis within the same range of components and theoretically inferring the impacts that define and characterize them. Further on, and based on possible impacts identified for project activities, intermediate areas were defined for each media, to finally conclude and establish the physical, biotic and socio-economic areas of influence over which it is foreseen the project activities will have a direct effect and over which the baseline characterization activities were carried out, as well as the assessment and identification of impacts along with the formulation of controlling, mitigation and compensation strategies.

The following is a delimitation and definition of the area of influence and a description of the area intervened by Rumichaca – Pasto highway project, Pedregal – Catambuco sector, defined as from the road layout.

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4.2. Definition, identification and delimitation of the Area of Influence

The area of influence is defined under the terms of reference for the formulation of Environmental Impact Studies for the construction of Tunnels and Highways (MADS, 2015), as an area where significant environmental impacts take place, caused by the development of a project, work or activity, over the biotic, non-biotic and socio-economic media for each component of formerly mentioned media.

The delimitation of an area of influence over which direct effects caused by project execution were foreseen, and over which the characterization of baseline, impact assessment and formulation of strategies for the management, compensation and mitigation of impacts for each component considered, the double lane Rumichaca to Pasto highway, Pedregal to Catambuco sector, yielded the integration of several components and media as follows: two areas of influence were defined. The first one corresponds to a physical and biotic area of influence, in respect to the consolidation of a single polygon in the non-biotic and biotic area of influence media, and the second one corresponds to an area of influence characterized by the socio-economic media.

4.2.1. Preliminary Areas of Influence

For the definition of a preliminary area of influence, a selection of components was carried out, as they were considered by a group of experts, as the most relevant ones to determine the criteria required to define the preliminary area of influence. Components selected were as follows: geospherical, here aspects such as soil, geology and geomorphology were considered; hydric resources, flora and political-organizational were considered as well.

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The theoretical criteria defined for the delimitation of the preliminary area of influence, according to the selected components were:

- Geospherical

The Geospherical component is paramount to establish the area of influence, given that the construction of road infrastructure requires the removal of soil and ground, the modification of geo-forms, resulting from excavation, cuts of terrain, fillings, disposal of surplus material (ZODME), transformation of materials and other sort of interventions over the physical media. These changes takes place over the area where the project is intervening.

The preliminary area of influence, from the Geospherical point of view, constitutes an intervention corridor demarcated by the work chamfers, both of them of cutting type as well as filling type plus the areas initially selected for the disposal of non-reusable excavation material -ZODME.

- Hydric

The preliminary area of influence considers micro-basins associated to hydric resources directly and indirectly affected by the project, taking into account the susceptibility or intrinsic predisposition of these hydric resources to sustain damages or loss when affected by projects of this kind (CGRTCA, 1999).

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The occupations of water streams or water sheds associated to the construction of new road infrastructure, and related infrastructure, (camp sites, ZODME, water captures, etc.), as well as water deviation and eventual discharges of water, and how that impact the existing water courses or impact the quality of existing hydric resources. Based on the former considerations, representative areas are defined to conduct an environmental analysis of real and potential impact of works over water bodies or over the quality of existing hydric resources.

Thus, a fundamental and preliminary criteria required is the definition of hydrographic basins and consider them as the minimum unit for analysis purposes. In this case, the analysis include micro-basins and sub-basins that could be affected by the project in the analysis.

- Flora

The building of road infrastructure implies the fractioning of eco-systems and vegetable cover that constitute connecting units for species that live in the zone. For this reason, biotic criteria used to delimit the preliminary Physical-Biotic area of influence correspond to natural cover and associated ecosystems that intercept with the project.


From the above mentioned theoretical criteria, which was selected using secondary information and initial interpretation of ecosystems and covers, a preliminary area of influence was delimited subject to verification in the field for subsequent

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determination, using primary information, of current affectation limits or extension of identified impacts within a project scenario.

Figure 4.4 shows the preliminary physical-biotic area of influence defined, in general terms, by the theoretical criteria formerly mentioned for the hydric component (micro-basins), given that the criteria set for other components (excepting the social) are immerse within the area.

Worth highlighting, the area of influence delimited under the micro basin concept guaranteed that all hydric and non-hydric elements were taken into account during the characterization process. This focus allows for a holistic approach integrating the most relevant aspects to characterize and assess projects of this type.

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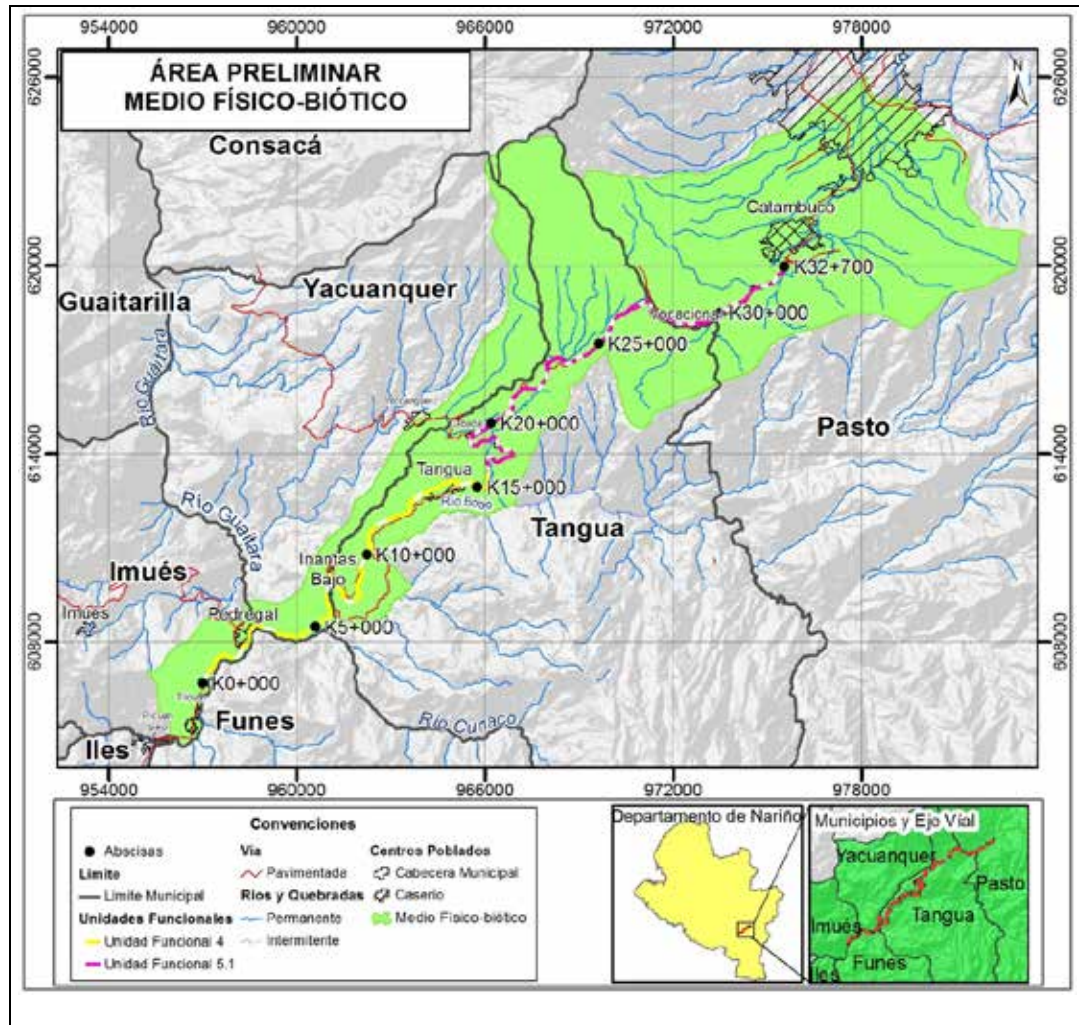



FIGURE 4.4 PHYSICAL-BIOTIC AREA OF INFLUENCE FOR THE DOUBLE LANE RUMICHACA – PASTO HIGHWAY, PEDREGAL – CATAMBUCO SECTOR

Source (Géminis Consultores Ambientales, 2016)

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- Political-Organizational

For the definition of the preliminary socio-economic area of influence, see Figura 4.5, the municipal boundaries of Imués, Yacuanquer, Tangua and Pasto were included, as well as those possible receptors of impacts derived from pre-construction, construction, dismantling and abandon activities that are part of the road building project.

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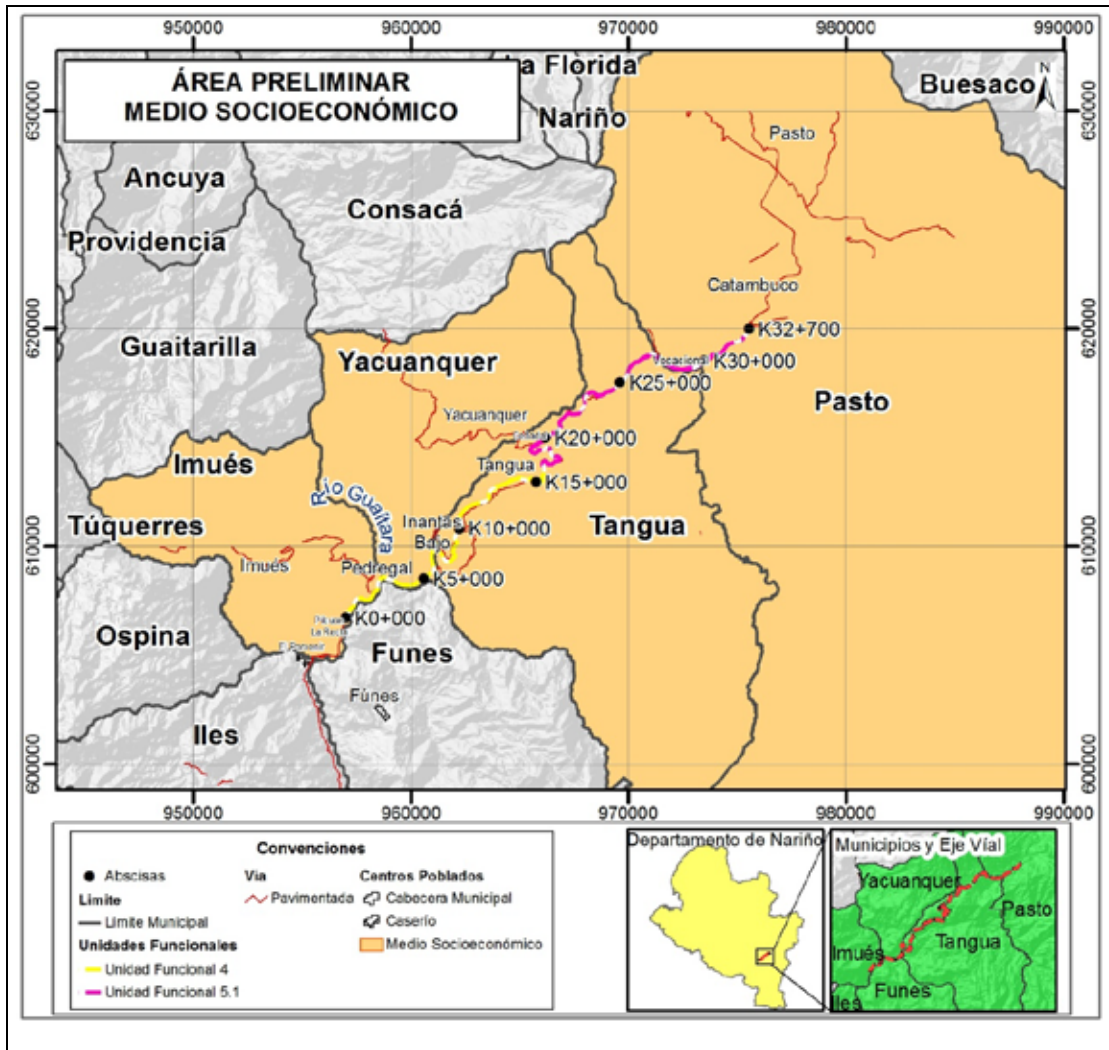



FIGURE 4.5 PRELIMINARY SOCIO-ECONOMIC AREA OF INFLUENCE OF THE DOUBLE LANE RUMICHACA – PASTO HIGHWAY, PEDREGAL – CATAMBUCO SECTOR

Source (Géminis Consultores Ambientales, 2016)

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Based on the preliminary socio-economic, physical-biotic areas of influence, it is necessary some work to lift field information for each element and component of the media; in addition, through community and institutional participation processes, the areas were socialized and criteria was identified to have a clear and final definition of the areas of influence.


4.2.2. Definition of Intermediate areas of influence

The following numerals present the delimitation of areas of influence for each media by way of irregular polygons where the factors or barriers for their delimitation are relative to their media or component analyzed. That is to say, for the non-biotic media, hydric, atmospheric and Geospherical factors are analyzed; for the biotic media, factors associated to cover area are analyze and for socio-economic media, territorial units are analyzed. The following is a detailed description of the process whereby said delimitation was carried out.

4.2.2.1. Non-biotic Media

Delimitation for the non-biotic area of influence was determined based on the analysis conducted over hydric and Geospherical media taking into account the type of impacts that could affect these components. On this regard, two polygons were delimited (hydric and Geospherical) for the non-biotic area of influence as follows:

Area of influence for the geospherical component, Pedregal – Catambuco sector

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To define the area of influence for the geospherical component, elements of the non-biotic media specifically related to this media were considered; among them, geology, geomorphology and agrology. As from minimum analysis units of each component (described in Chapter 5 of this study) the area of influence was defined for the geospherical component.

Table 4.1 describes each component with the corresponding minimum analysis units evaluated along with observations made over the selection of criteria utilized for delimitation. Figure 4.6 presents the area of influence defined for the geospherical component for the Pedregal – Catambuco sector.

TABLE 4.1 COMPONENTS OF SOIL RESOURCE ANALYZED TO DEFINE THE AREA OF INFLUENCE FOR THE GEOSPHERICAL COMPONENT, PEDREGAL - CATAMBUCO SECTOR

Component	Minimum unit of analysis	Observations over the definition of the area of influence
Geology	Geological unit	Represent large units where impacts do not show beyond the project's area of influence
Geomorphology	Geomorphological unit	
Soil	Agrological unit	

Components and their minimum units of analysis were characterized and defined in detail in Chapter 5 of this study. The cartographic delimitation of each unit can be seen in the project's GDB.

Source: (Géminis Consultores Ambientales, 2016)

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Impacts assessment for geospherical component

Once the geospherical component was characterized and possible project impacts were assessed, a final delimitation was obtained for this area of influence. The following are the impacts considered determinant for the delimitation process.

Geo-forms: at geo-form level, transformations produced by the configuration of the construction of the double lane highway and possible changes in the stability of hydric borders were analyzed, as well as the instability of embankment slopes, considering there are impacts generated mainly by the cutting of vegetable cover, removal of the soil and excavations throughout the road corridor. There is also clear evidence of alterations of geo-forms in the ZODME areas.

Ground: one possible impact over this component correspond to changes in the structure of the ground that could be possibly generated mainly by cutting of vegetable cover and soil removal, excavations and operations in areas destined to ZODME. This impact is also associated, among others, to the generation of solid residues around the project's area of intervention. Another impact over the ground comes from the modification of current use of the soil, generated mainly by the removal of vegetable cover and topsoil stripping activities, a change over the area of intervention that could extend to the unit of soil intervened (minimum unit of analysis).

Landscape: For landscape, this corresponds to elements associated to the non-biotic media (geo-forms), biotic (vegetable cover) and socio-economic (landscape places of interest) where impacts are associated to modification of the landscape due mainly to removal of vegetable cover and topsoil stripping. Interventions over elements that conform the landscape are carried

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out on a specific manner inside the area of intervention. However, possible modifications could happen over the associated cover unit, for which reason impact over this component are related to the delimitation of the biotic area of influence.

Once each geospherical component has been characterized and possible environmental impacts caused by executing the Pedregal to Catambuco project are defined, the corresponding area of influence for this component is then define, associated to the area of intervention, which implies that the area initially established as preliminary area, from the theoretical point of view for this group of components, can be maintained provided there is no evidence of significant, quantifiable and qualifiable impacts affecting the different geospherical media components beyond the areas directly intervened by the project. Thus, for instance, the geological units of ground only suffer from significant alterations when soil and rock removal activities are developed, and landscape units are only modified where the second highway lane is constructed.

The following is a table that summarizes the ground units associated to the area of influence and square area these units represent for total delimited area which is characterized in Chapter 5 of this study (see Table 4.2 and Figure 4.6).


TABLE 4.2 CURRENT USE OF THE SOIL AS INTEGRAL PART OF THE GEOSPHERICAL COMPONENT, PEDREGAL – CATAMBUCO SECTOR

CURRENT USE	NOMENCLATURE	AREA (hectares)
Transportation	Tp	39,79

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CURRENT USE	NOMENCLATURE	AREA (hectares)
Conservation	Cn	152,62
Agriculture	Ag	127,16
Forestry	Ft	20,90
Urban	Ub	73,94
Farming & cattle	Ap	499,17
Cattle	Gn	335,73
Industrial	In	6,32
TOTAL AREA OF INFLUENCE (GEOSPHERICAL)		1255,63

Fuente: (Géminis Consultores Ambientales, 2016)

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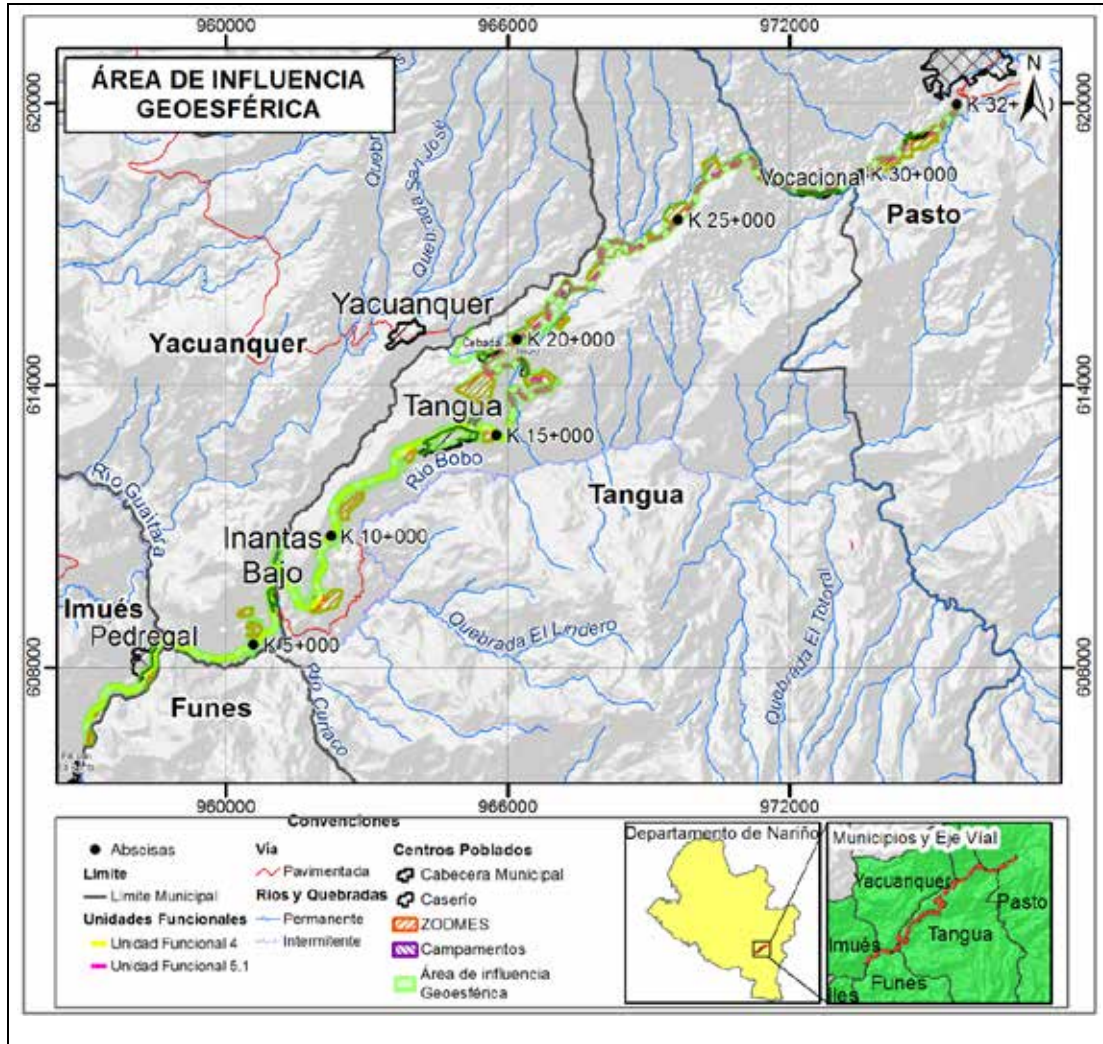



FIGURE 4.6 AREA OF INFLUENCE OF THE GEOSPHERICAL COMPONENT OF THE DOUBLE LANE HIGHWAY PROJECT, RUMICHACA – PASTO, PEDREGAL – CATAMBUCO SECTOR

Source: (Géminis Consultores Ambientales, 2016)

(See GDB/cartography/PDF/code/ EIADCRP_PC_003.2.2)

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Area of influence for the hydric resource

To establish the project's area of influence, affecting hydric resources, hydrological conditions of the region were analyzed along with specific hydraulic conditions prevailing throughout the intervention corridor of the double lane highway project, specifically the sector going from Pedregal to Catambuco part of the overall double lane highway Rumichaca to Pasto project.

Specifically, for the hydric resource, there is a verification upstream of the chamfer boundary (upper limit or upstream the intervention area) to confirm there is no affectation of the natural conditions of water bodies that cross the project, for which reason it has been established that it constitutes the criteria utilized to delimit the in intermediate area of influence of upstream hydric component. Also, it was possible to establish that the direction of runoffs defines the limits of this component downstream of those sectors where no water bodies exist or if water streams mouths are too far away to consider them as receptors of impacts generated from the intervention of water bodies that cross the project. Likewise, all sampling points, captures of water, uses and users of water were included in this area.

For superficial water bodies, those to be intervened by the project's activities were considered, such as water captures and discharges due to project works.


In this sense, a differentiated area of influence was delimited based on the methodology established by IDEAM. The following is a list of water bodies that will be intervened by project activities corresponding to Pedregal – Catambuco sector, as from which the hydric area of influence was delimited (See Table 4.3).

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The road corridor and infrastructure associated to the project, such as camp sites, plants and ZODMEs, do necessarily have water bodies in their vicinity, for which reason the design and activities to be carried out consider the adoption of careful measures aim at protecting the river course and embankment and hydric resources, plus monitoring of activities to make sure indications provided by the norms are complied with. Associated infrastructure will not intervene the hydric courses nor will it affect the water quality.


The following table show the area of influence of hydric resources defined on permanent and intermittent drainages that cross the double lane highway Rumichaca – Pasto, Pedregal – Catambuco sector layout. (See Table 4.3 and Figure 4.7).

TABLE 4.3 DRAINAGES IN THE AREA OF INFLUENCE OF HYDRIC RESOURCES, DOUBLE LANE HIGHWAY RUMICHACA – PASTO PROJECT, PEDREGAL – CATAMBUCO SECTOR

UF	NAME OF SOURCE	TYPE	TEMPORAL	COORD_X	COORD Y	PHOTOGRAPHIC EVIDENCE
4	WITHOUT NAME 1	SEWAGE 0+993	NO RECORD	957447,30	607459,31	

4	WITHOUT NAME 2	SEWAGE 1+193	NO RECORD	957656,89	607587,23	
4	WITHOUT NAME 3	SEWAGE 4+673	NO RECORD	960309,21	608351,84	
4	WITHOUT NAME 4	SEWAGE 5+300	NO RECORD	960802,12	608702,69	

4	WITHOUT NAME 5	SEWAGE 5+915	NO RECORD	961022,95	609139,77	
4	WITHOUT NAME 6	SEWAGE 8+212	NO RECORD	961762,85	609272,40	
4	WITHOUT NAME 8	SEWAGE 8+420	NO RECORD	961925,48	609395,96	

4	WITHOUT NAME 9	SEWAGE 7+952	NO RECORD	961539.97	609370.06	
4	WITHOUT NAME 10	SDN-1	NO RECORD	960945,11	609578,11	
4	WITHOUT NAME 11	SEWAGE 7+593	NO RECORD	961384.18	609687,67	

4	WITHOUT NAME 12	SEWAGE 7+425	NO RECORD	961266.95	609818.61	
4	WITHOUT NAME 13	SEWAGE 8+843	NO RECORD	961933.68	609772.62	
4	WITHOUT NAME 14	SEWAGE 6+659	NO RECORD	960962.53	609864.85	

4	WITHOUT NAME 15	SDN-2	NO RECORD	961219,79	609953,13	
4	WITHOUT NAME 16	SDN-3	NO RECORD	960942.03	610060.10	
4	LA MAGDALENA WATER STREAM	DRAINAGE 2	NO RECORD	961055,98	610135.72	

4	WITHOUT NAME 17	SEWAGE 9+473	NO RECORD	962041,06	610310.03	
4	WITHOUT NAME 18	SEWAGE 9+522	NO RECORD	962012.10	610390.13	
4	WITHOUT NAME 19	SEWAGE 9+647	NO RECORD	962055,15	610503.21	

4	WITHOUT NAME 20	SEWAGE 13+038	NO RECORD	963995,74	612730,24	
4	WITHOUT NAME 21	SEWAGE 13+421	NO RECORD	964354,29	612873,85	
4	WITHOUT NAME 22	SEWAGE 13+862	NO RECORD	964746,31	613063,84	

4	WITHOUT NAME 23	SDN-4	NO RECORD	964812,34	613086,11	
4	WITHOUT NAME 24	SEWAGE 14+026	NO RECORD	964901,36	613116,88	
4	WITHOUT NAME 25	SEWAGE 14+234	NO RECORD	965097,95	613119,39	

4	WITHOUT NAME 26	BOX CULVERT – 3	NO RECORD	957048,31	606818,50	
4	WITHOUT NAME 27	SEWAGE 0+232	NO RECORD	957087.60	606898,26	
4	WITHOUT NAME 28	SEWAGE 0+518	NO RECORD	957244,55	607135,06	

4	GUAITARA RIVER	VIADUCT	NO RECORD	958736,48	608557,67	
5	WITHOUT NAME 29	BOX CULVERT - 1	NO RECORD	966054,29	613847,89	
5	WITHOUT NAME 30	SEWAGE 16+948	NO RECORD	966628,23	613872,95	

5	WITHOUT NAME 31	DRAINAGE 3	NO RECORD	966804,19	614104,07	
5	WITHOUT NAME 32	BOX CULVERT – 8	NO RECORD	966463,97	614224,22	

Source: (Géminis Consultores Ambientales, 2016)

Impacts assessed for the hydric component


1

At hydric resource level, impacts associated to changes of physical-chemical properties of superficial water are identified, that could come mainly from construction activities executed over water bodies associated to the project as well as possible changes of transportation capacity of the hydric resource. There could also exist impacts over the supply of hydric resources related to water capture activities associated to the installation of plants and in general to the development of project construction.

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According to the former considerations, impact over hydric resources are present over the totality of water bodies intercepted by the project as well as over water sources having water capture points.

As from impacts identified, the area of influence for the hydric resource is delimited based on the water bodies directly associated to the project both due to construction activities as well as due to the capture of water activities. Figure 4.7 below, graphically show total area delimited for the hydric resource of Rumichaca – Pasto project, Pedregal – Catambuco sector.

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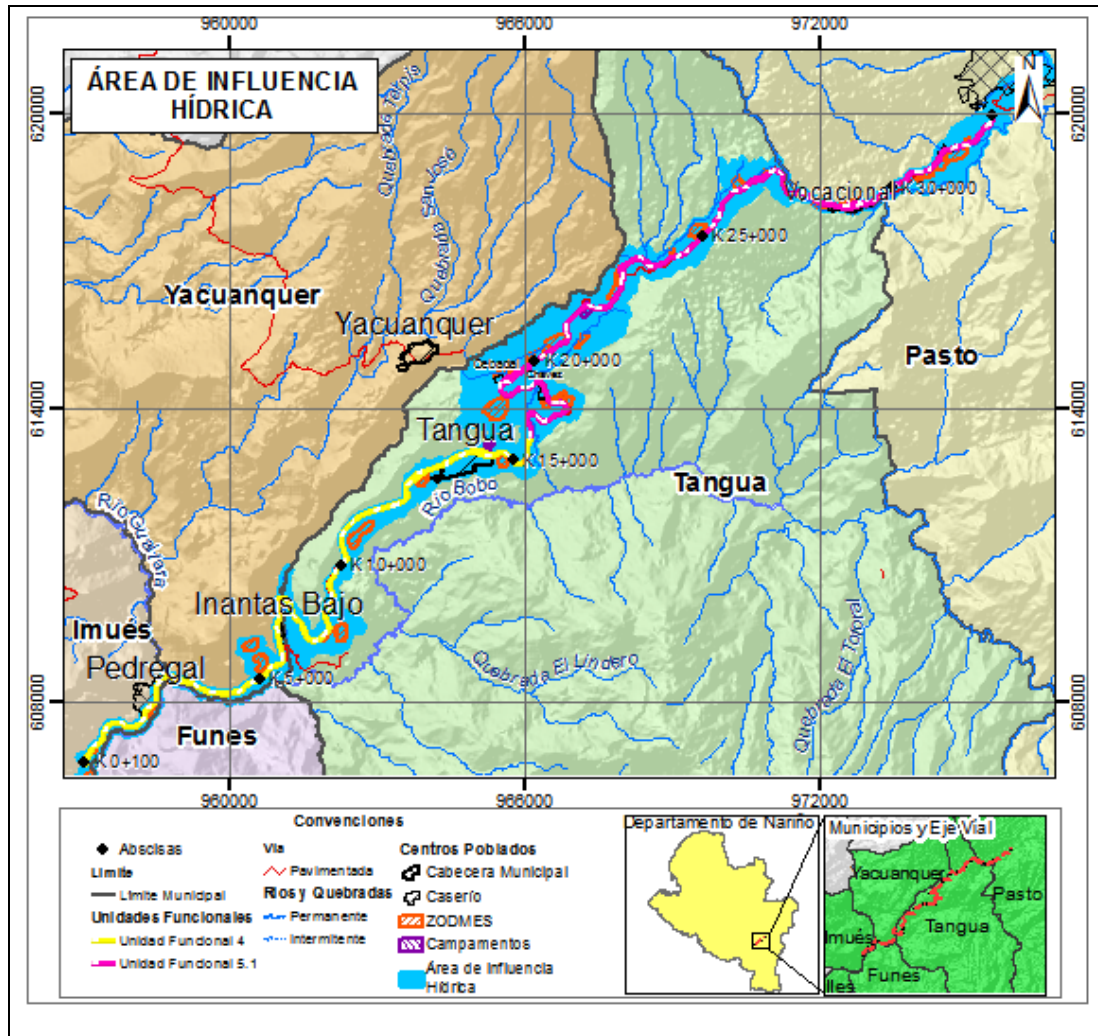



FIGURE 4.7 AREA OF INFLUENCE OF HYDRIC RESOURCE FOR THE DOUBLE LANE HIGHWAY RUMICHACA – PASTO PROJECT, PEDREGAL – CATAMBUCO SECTOR

Source: (Géminis Consultores Ambientales, 2016)

(See GDB/cartography/PDF/code/ EIADCRP_PC_003.2.1)

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Area of influence of the atmospheric component

To delimit the intermediate area of influence of the atmospheric component, the results yielded by the atmospheric dispersion model were utilized. This model evaluated several contaminants according to the emission sources foreseen for the project.

Particulate material – PM10, was chosen as the delimiting agent of the area of influence for the atmospheric component, given that this is a contaminant of interest according to fixed emission sources identified for this project (numeral 7.6.1.) and due to the quality of air norm –Resolution 610 of 2010 issued by the Ministry for the Environment and Sustainable Development -MAVDT , which establishes for this contaminant a maximum allowable level of 50 µg/m³ per year, and of 100 µg/m³ per day, on top of the importance given to particles of less than 10µ in size due to their affectation to human health.

Impacts assessed for the atmospheric component

Two kind of impacts were mainly considered for this component: changes in the quality of air and changes in sound pressure levels. These impacts are assessed for plant installation activities and plant operations (asphalt, concrete and crushing plants) and valued as severe, followed by the demolition and operation of ZODMES activities which were scored in the impact assessment as moderate.

Figure 4.8 below, show the intermediate area of influence for the atmospheric component.

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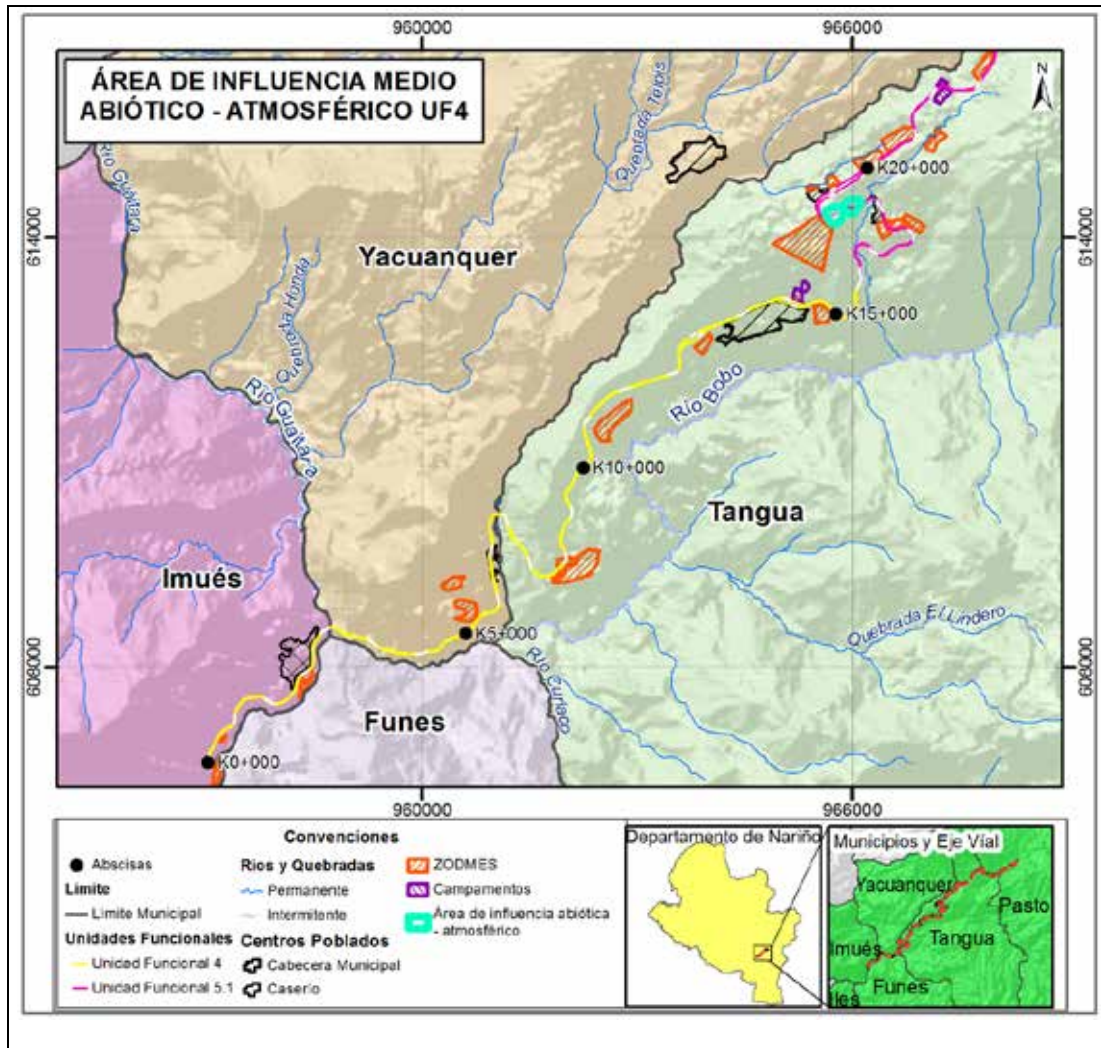



FIGURE 4.8 AREA OF INFLUENCE OF THE ATMOSPHERIC COMPONENT FOR THE DOUBLE LANE RUMICHACA – PASTO HIGHWAY PROJECT, PEDREGAL – CATAMBUCO SECTOR, FUNCTIONAL UNIT 4

Source (Géminis Consultores Ambientales, 2016)

(See GDB/cartography/PDF/code/ EIADCRP_PC_003.2.3)

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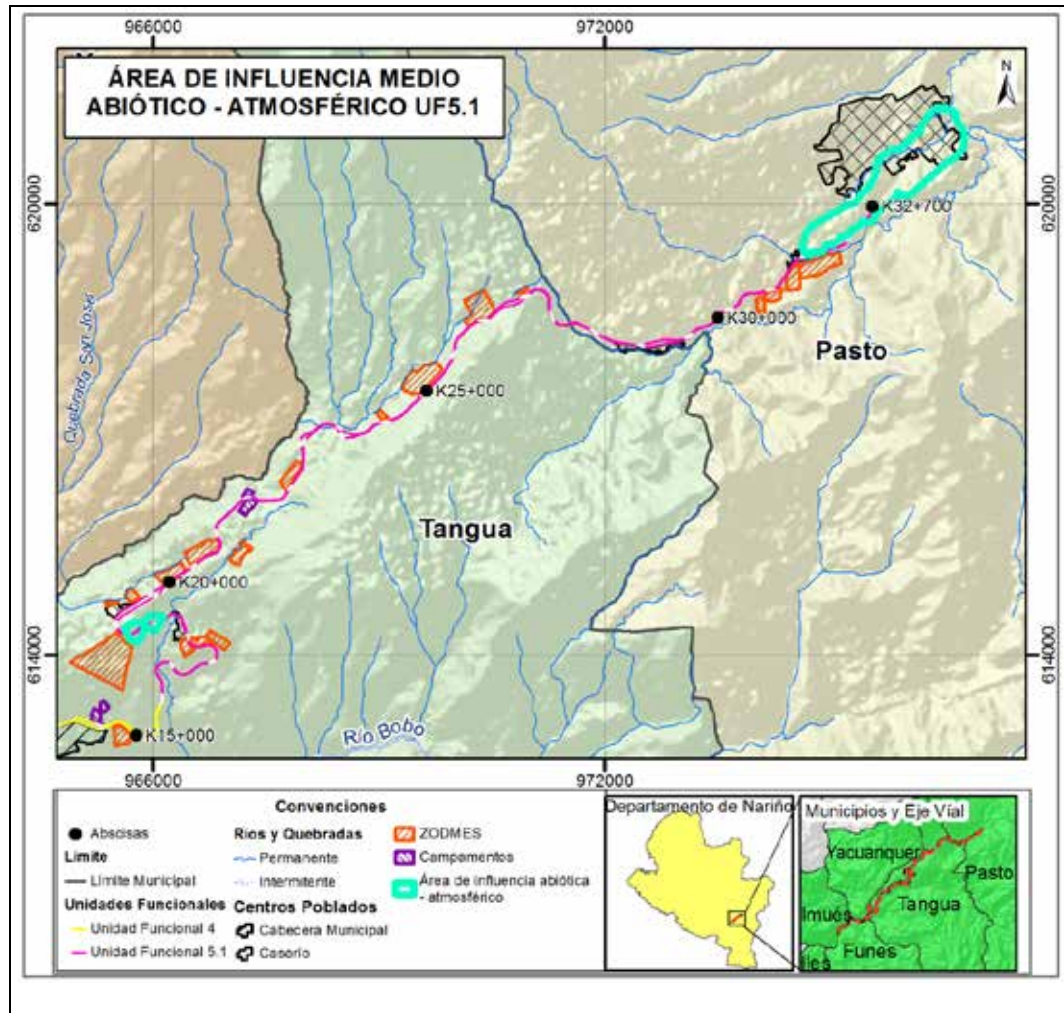




FIGURE 4.9 AREA OF INFLUENCE OF THE ATMOSPHERIC COMPONENT FOR THE DOUBLE LANE RUMICHACA – PASTO, HIGHWAY PROJECT, PEDREGAL – CATAMBUCO SECTOR, FUNCTIONAL UNIT 5.1

Source (Géminis Consultores Ambientales, 2016)

(See GDB/cartography/PDF/code/ EIADCRP_PC_003.2.3)

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As a result of the cartographic analysis of prior definitions of area of influence for geospherical, atmospheric and hydric components, on top of other criteria such as the trajectory of some hydric sources, level curves and ground units at 1:100.000 scale plus small water division lines, it was possible to obtain the area of influence for the non-biotic media as it is shown in Figure 4.10.

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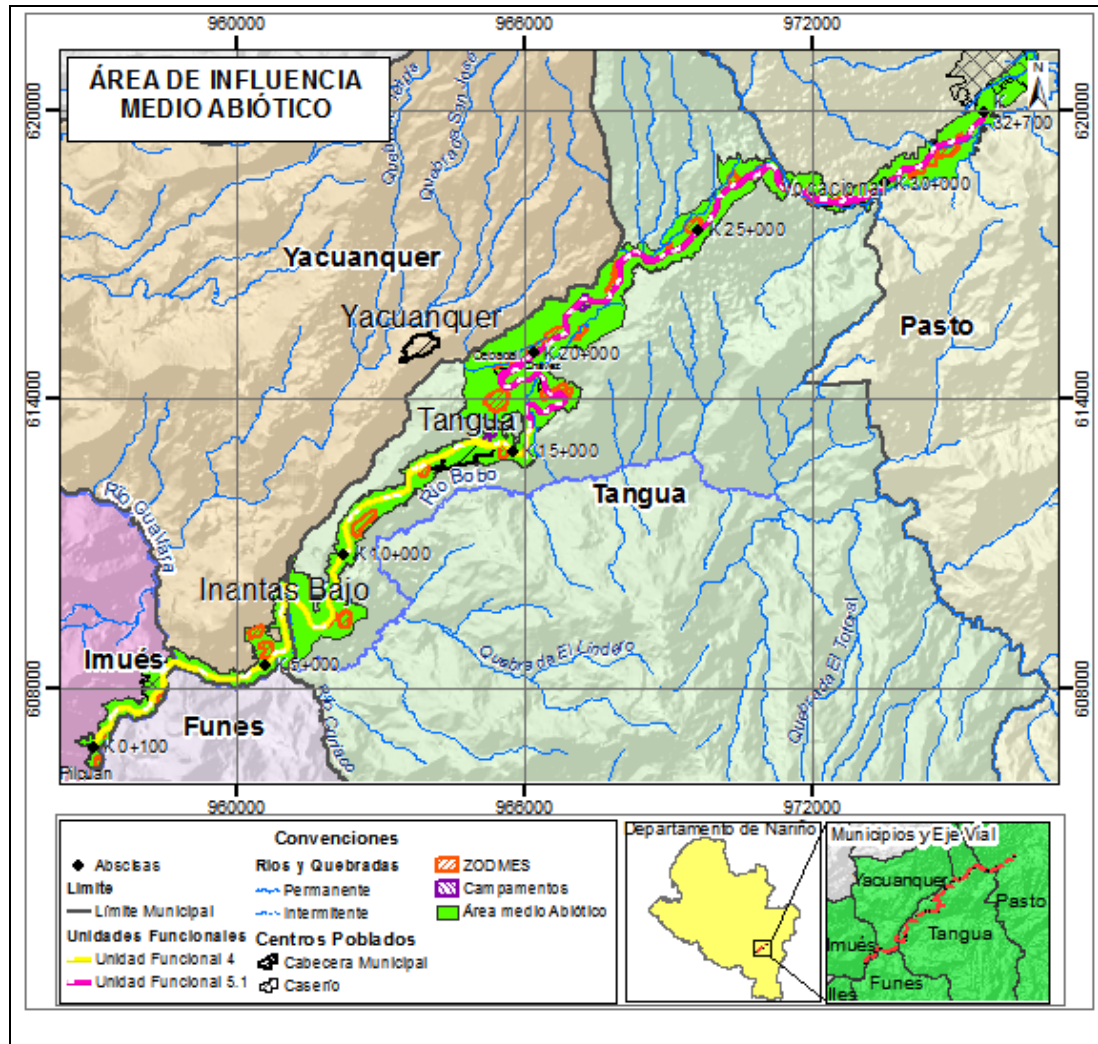


FIGURE 4.10. AREA OF INFLUENCE OF NON-BIOTIC MEDIA FOR THE DOUBLE LANE HIGHWAY RUMICHACA – PASTO PROJECT, PEDREGAL – CATAMBUCO SECTOR

Source: (Géminis Consultores Ambientales, 2016)


(See GDB/cartography/PDF/code/EIADCRP_PC_003.2)

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4.2.2.2. Biotic Media

The determination of the biotic area of influence of the double lane Rumichaca-Pasto highway project, Pedregal-Catambuco sector, was carried out based on the analysis of ecosystems that exist in the zone and vegetable cover associated to that zone, taking into account connectivity factors and their use as a natural habitat for associated fauna communities.

Ecosystems identified were obtained based on altitude and temperature ranges, according to continental ecosystem maps, Colombian coast and maritime maps produced between the Meteorology, Hydrology and Environmental Studies Institute –IDEAM, Agustin Codazzi Geographical Institute -IGAC, Research Institute for Biological Resources Alexander von Humboldt -IAvH, Environmental Research Institute for the Pacific John von Neumann -IIAP, Marine and Coastal Research Institute José Benito Vives de Andrés –INVEMAR and the Amazonian Scientific Research Institute –SINCHI in 2007, at a 1:500.000 scale. Based on this information a cartography was produced at a 1:25.000 scale detailing existing ecosystems as can be seen in Figure 4.11 and Figure 4.12., the former was complemented with bio-geographical districts and eco-regions, as established by Corzo and Andrade, to increase the level of detail according to project’s punctual conditions.

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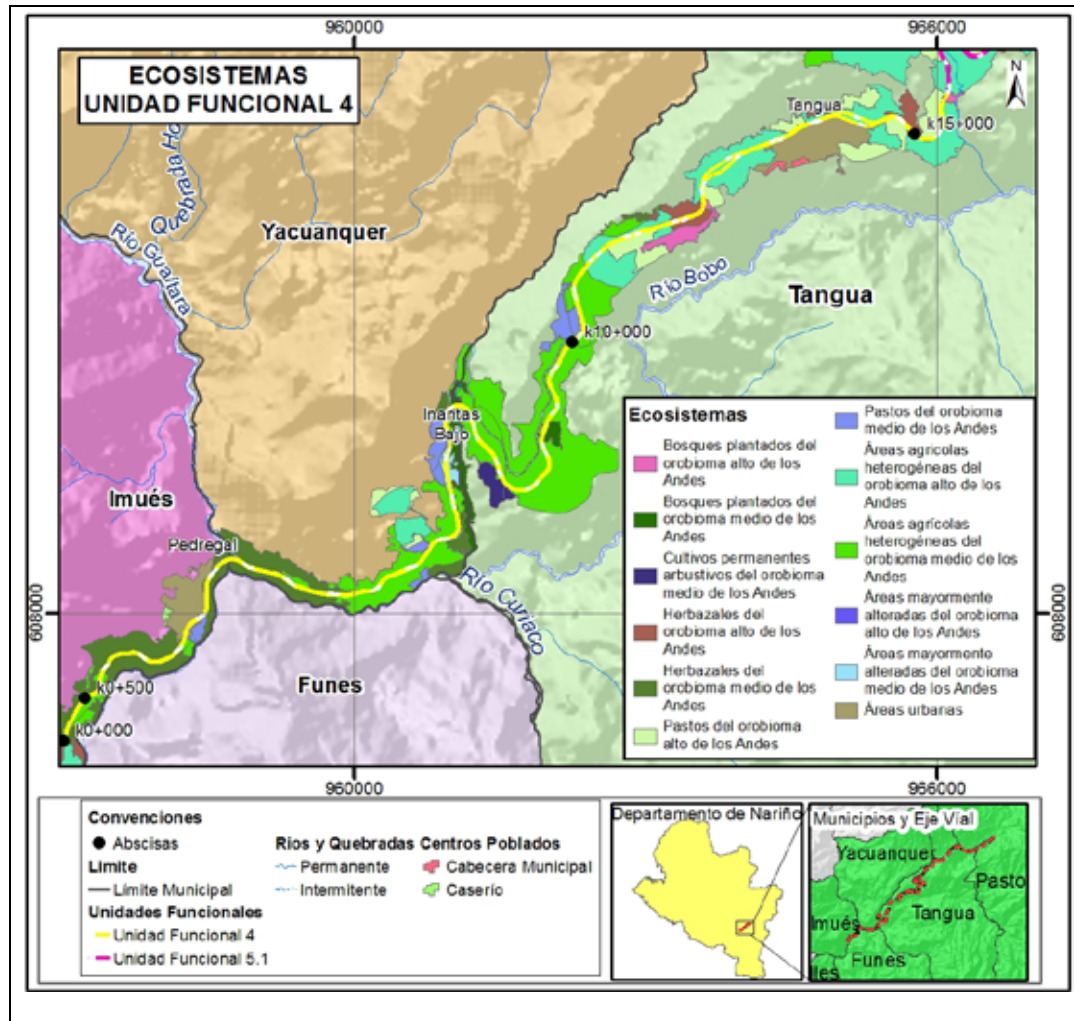



FIGURE 4.11. FUNCTIONAL UNIT 4 ECOSYSTEMS FOR THE DOUBLE LANE RUMICHACA – PASTO HIGHWAY PROJECT, PEDREGAL – CATAMBUCO SECTOR

Source: (Géminis Consultores Ambientales, 2016)

(See GDB/cartography/PDF/code/ EIADCRP_PC_023)

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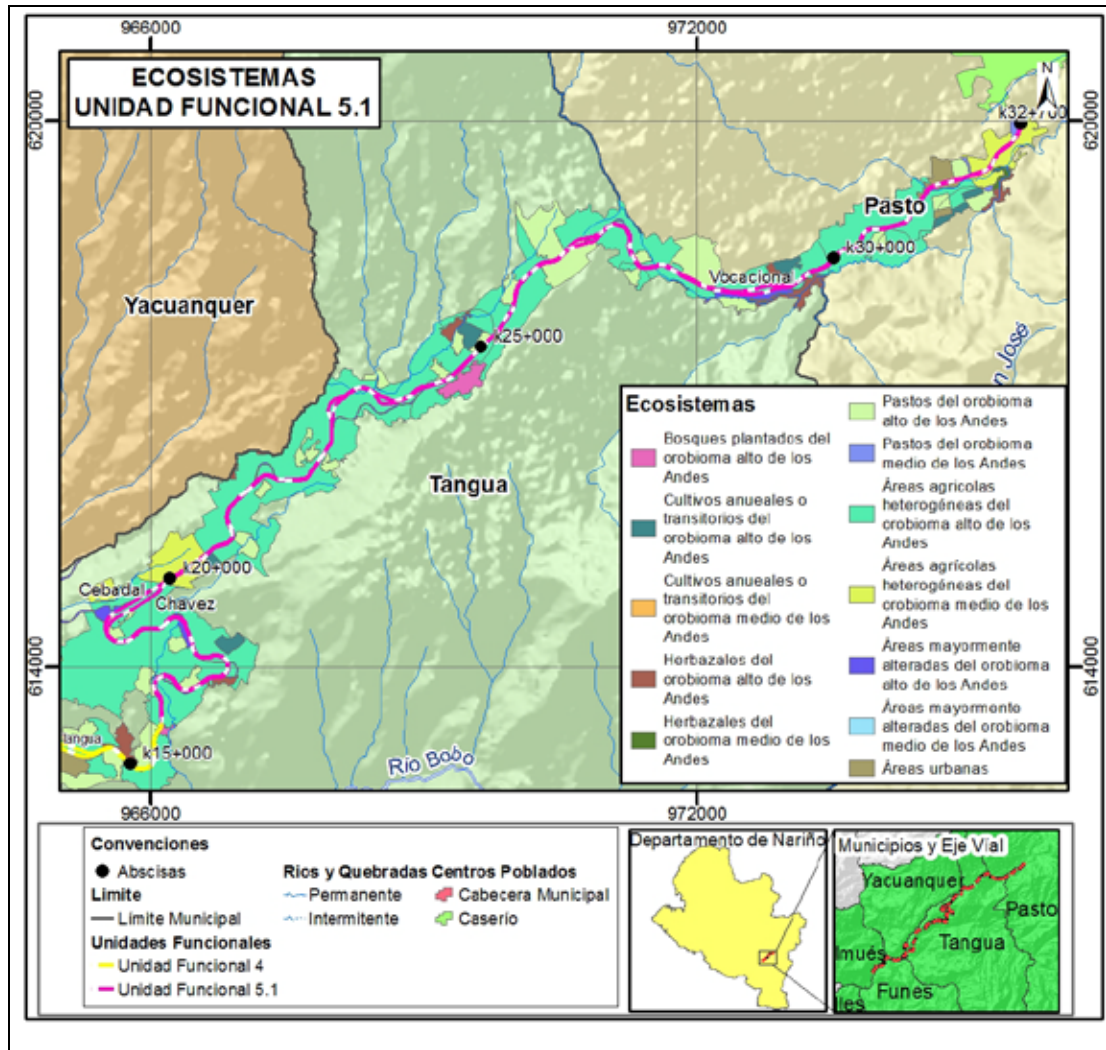


FIGURE 4.12. FUNCTIONAL UNIT 5 ECOSYSTEMS, SUBSECTOR 1 OF DOUBLE LANE RUMICHACA – PASTO HIGHWAY PROJECT, PEDREGAL – CATAMBUCO SECTOR

Source: (Géminis Consultores Ambientales, 2016)

(See GDB/cartography/PDF/code/ EIADCRP_PC_023)


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The overall area of influence of the double lane Rumichaca to Pasto highway belongs to the Great Gran Tropical Rain Forest Biome, in particular to the Middle Andes Oro-Biome and to the High Andes Oro-Biome.

The following is a list of land ecosystems identified in the area of influence of the double lane Rumichaca – Pasto highway project, Pedregal – Catambuco sector.

TABLE 4.4 LAND ECOSYSTEMS IDENTIFIED IN THE AREA OF INFLUENCE OF THE DOUBLE LANE RUMICHACA – PASTO HIGHWAY PROJECT, PEDREGAL – CATAMBUCO SECTOR

COVER	NOMENCLATUR E	AREA (hec)	%
Dense bushes of high Andes Oro-biome	213221	7,70	0,40
Dense bushes of middle Andes Oro-biome	203221	15,03	0,78
Gallery forest and/or border forest of high Andes Oro-biome	21314	8,01	0,41
Harvests and trees planted on middle Andes Oro-biome	202242	33,87	1,75
Harvests mosaic planted in high Andes Oro-biome	21241	68,01	3,52
Harvests mosaic planted in middle Andes Oro-Biome	20241	134,06	6,93
Harvests mosaic and natural spaces in high Andes Oro-Biome	21245	10,97	0,57
Harvest mosaic, pastures and natural spaces in high Andes Oro-Biomed	21243	77,98	4,03
Harvest mosaic, pastures and natural spaces in middle Andes Oro-Biomed	20243	146,70	7,59
Pastures mosaic with natural spaces in high Andes Oro-biome	21244	82,35	4,26
Pastures mosaic with natural spaces in middle Andes Oro-Biome	20244	114,71	5,93
Pastures and harvest mosaic in high Andes Oro-Biome	21242	254,69	13,1

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COVER	NOMENCLATUR E	AREA (hec)	%
			7
Pastures and harvest mosaic in middle Andes Oro-Biome	20242	226,91	11,73
Other transitory harvests in high Andes Oro-Biome	21211	10,58	0,55
Other transitory harvest in middle Andes Oro—Biome	20211	4,53	0,23
Potato in high Andes Oro-Biome	212151	6,85	0,35
Potato in middle Andes Oro-Biome	202151	5,18	0,27
Pastures and weed in high Andes Oro-Biome	21233	24,53	1,27
Pastures and weed in middle Andes Oro-Biome	20233	56,37	2,92
Clean pastures in high Andes	21231	84,07	4,35
Clean pastures in middle Andes	20231	67,96	3,51
Pastures and planted trees in high Andes	212241	64,34	3,33
Pastures and planted trees in middle Andes	202241	58,52	3,03
Forest plantation in high Andes Oro-Biome	21315	10,32	0,53
Forest plantation in middle Andes Oro-Biome	20315	14,97	0,77
Road and train network on land associated to high Andes Oro-Biome	21122	13,99	0,72
Road and train network on land associated to middle Andes Oro-Biome	20122	34,55	1,79
Non-continuous urban building in high Andes Oro-Biome	21112	8,10	0,42
Non-continuous urban building in middle Andes Oro-Biome	20112	40,77	2,11
Industrial and commercial zones in high Andes Oro-Biome	21121	4,62	0,24
Industrial and commercial zones in middle Andes Oro-Biome	20121	0,06	0,00
Gallery forest and/or border forest in middle Andes Oro-Biome	20314	21,32	1,10

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COVER	NOMENCLATUR E	AREA (hec)	%
Coffee of middle Andes Oro-Biome	202222	8,36	0,43
Grass in open rocks in middle Andes Oro-Biome	2032122	112,19	5,80
Harvest mosaic and natural spaces in middle Andes Oro-Biome	20245	21,02	1,09
Pastures and trees bin middle Andes Oro-Biome	20232	3,15	0,16
Rivers (50 mts) in middle Andes Oro-Biome	20511	20,89	1,08
Continuous urban buildings in middle Andes Oro-Biome	20111	55,36	2,86
		1933,61	100

Source: (Géminis Consultores Ambientales, 2016)

The following is a brief description of land ecosystems distribution that are part of the biotic area of influence.

1 **Biomes**

2 Biomes are taken as “large and uniform environments of a biosphere in an homogeneous
3 area, in biophysical terms, located within the same biogeographical formation”; therefore, a
4 biome could be considered as a group of kindred land ecosystems given their similar
5 structural and functional profiles, differentiated by their vegetable characteristics. IDEAM et
6 al. (2007). Three large biomes are define for the entire country: the great tropical dessert
7 biome, the great dry tropical forest biome and the great tropical rain forest biome. Within
8 these three biomes, 34 other biomes are identified for the entire national territory.

9


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1 According to this classification, it is possible to determine that the project's area of influence
2 goes from the municipal town of Imués to the capital city of Nariño department, an area that
3 is located between the middle Andes Oro-Biome and the high Andes Oro-Biome.

4 It is important to highlight that due to the high level of anthropogenic intervention of
5 project's area of influence, the ecosystems do not preserve their natural characteristics,
6 showing little forest coverage and semi-natural ecosystems given they have been strongly
7 intervened by the expansion of agricultural and cattle growing boundaries, replacing native
8 vegetable species for areas dedicated to grazing and mono-cultivations.

9 **Middle Andes Oro-Biome**

10 It characterizes for having three main types of climate: dry cold, humid cold and dry
11 temperate climates. For the most part, the Oro-biome is exposed to frequent fog that forms
12 at heights between 1800 and 2800 mts above sea level, with temperatures that oscillate
13 between 1°C and 18°C. The most representative geo-morphological units of this Oro-Biome
14 are mountains and plateau.

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PICTURE 4.1 HETEROGENEOUS AGRICULTURAL AREAS OF MIDDLE ANDES ORO-BIOME, TOWNSHIP OF CATAMBUCO, MUNICIPALITY OF PASTO.

MAGNA SIRGAS COORDINATE, WEST ORIGIN **X: 966833; Y: 615291 PK 30+800**

Source: (Géminis Consultores Ambientales, 2016)

1 High Andes Oro-Biome

2

3 Located in different sections of high Central-East and West mountain ranges slopes,
 4 surrounding the Guaitara river basin while bordering the high moorlands (at altitudes
 5 above 3000 meters above sea level on andisol grounds formed from volcanic ashes, little
 6 evolved, superficial and of low fertility, undulated to sharp relief and steep relief for slopes
 7 above 75%; with high permanent humidity (relative humidity above 80%), temperatures
 8 ranging from 8°C to 12°C, strong winds, moderate and constant, and some presence of frost.
 9 Due to the influence of fog and low potential of evaporation-transpiration (between 0.25
 10 and 0.5), less than the amount of rain water (average annual precipitation of 1.000 to 2.000
 11 mm) there is permanent generation of excess water.

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PICTURE 4.2 CLEAN GRASS OF HIGH ANDES ORO-BIOME, MUNICIPALITY OF TANGUA-NARIÑO.

MAGNA SIRGA COORDINATE, WEST ORIGIN X 965387 Y 613169

PK 15+00

Source: (Géminis Consultores Ambientales, 2016)

A high level of anthropogenic intervention is pretty evident for the road project and its area of influence where ecosystems do not preserve their natural characteristics.

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Determination of ecosystems located inside the double lane Rumichaca-Pasto highway project, Pedregal-Catambuco sector, was carried out as from existing vegetable cover such as it is listed in the following table.

TABLE 4.5. GROUND COVER IDENTIFIED FOR THE AREA OF INFLUENCE

N1_COVER	N2_COVER	LEVEL			NOM ENCL ATU RE	AREA	%
		N3_COVER	N4_COV ER	N5_CO VER			
Artificial territories	Urban zones	Continuous urban building			111	55,36	2,86
		Non continuous urban building			112	48,87	2,53
	Industrial or commercial and communication network zones	Industrial or commercial zones			121	4,69	0,24
		Road and rail network and associated ground			122	48,54	2,51
Agricultural territories	Transitory harvests	Other transitory harvests			211	15,11	0,78
		Tuber	Potato		2151	12,03	0,62
	Permanent harvest	Permanent bushy harvests	Coffee		2222	8,36	0,43

		Agro-forestry cultivations	Planted grass and trees		2241	122,86	6,35
		Agro-forestry cultivations	Planted cultivations and trees		2242	33,87	1,75
	grassland	Green grass			231	152,03	7,86
		Grass and bushes			232	3,15	0,16
		Grass and weed			233	80,90	4,18
	Heterogeneous agricultural areas	Harvest mosaic			241	202,07	10,45
		Grass and harvest mosaic			242	481,60	24,91
		Grass and harvest mosaic and natural spaces			243	224,68	11,62
		Grass mosaic with natural spaces			244	197,07	10,19
		Harvest mosaic and natural spaces			245	32,00	1,65
	Forests and semi-natural spaces	Areas with herbaceous cover and/or bushes	Bushy	Dense bushes		3221	22,73
Herbaceous			Open herbaceous areas	Rocky open herbaceous areas	32122	112,19	5,80
Forests		Gallery forest			314	29,32	1,52

		and/or border forest					
		Forest plantation			315	25,30	1,31
Superficial water bodies	Continental waters	Rivers (50 mts)			511	20,89	1,08
TOTAL						1933,6	100
						1585	

1

Source (Géminis Consultores Ambientales, 2016)

Impacts assessed for the biotic component


Vegetable Cover: possible impacts over this component are associated to the modification of vegetable cover, changes of vegetable cover protecting water bodies and changes in the abundance of species in danger and/or forbidden to hunt or capture. These type of impacts are mainly associated to removal of vegetable cover, topsoil stripping and removal of forest cover and they take place in punctual areas of intervention.

Wild Fauna: possible generation of impact over wild fauna correspond to fragmentation of fauna habitat resulting mainly from removal of vegetable cover and topsoil stripping. Notwithstanding these activities are carried out on a punctual manner, the impact over fauna is seen at habitat level which is define by covers associated to the project.

Hydro-biological communities: impacts associated to sweet water species are seen on water bodies associated to the project due mainly to the construction of infrastructure such as bridges that provide cover over rivers.

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Figure 4.13 and Figure 4.14 show, cartographically, the biotic area of influence of the double lane Rumichaca – Pasto highway project, Pedregal – Catambuco sector.

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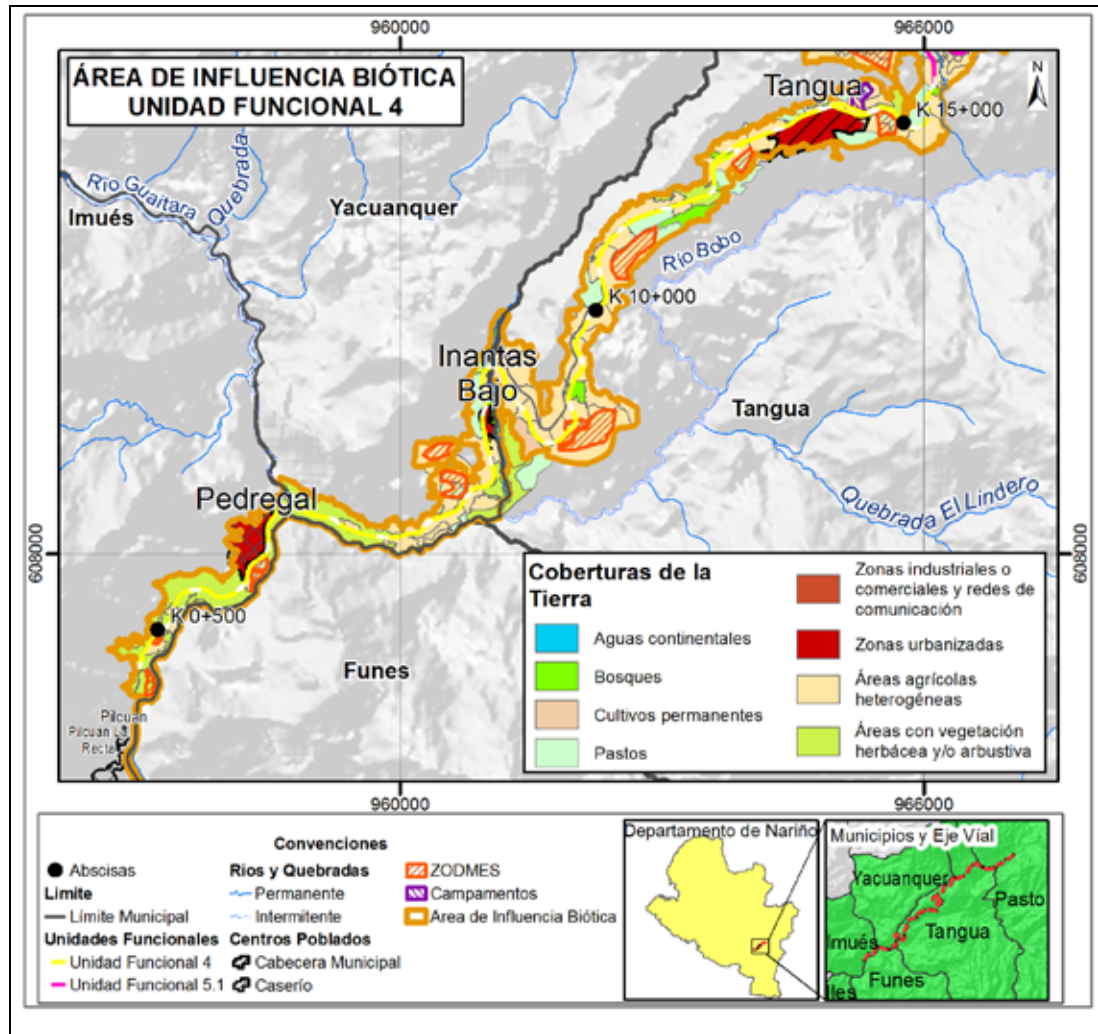



FIGURE 4.13 AREA OF INFLUENCE OF BIOTIC MEDIA – FUNCTIONAL UNIT 4, DOUBLE LANE RUMICHACA – PASTO HIGHWAY PROJECT, PEDREGAL – CATAMBUCO SECTOR

Fuente: (Géminis Consultores Ambientales, 2016)

(See GDB/cartography/PDF/code/ EIADCRP_PC_003.1)

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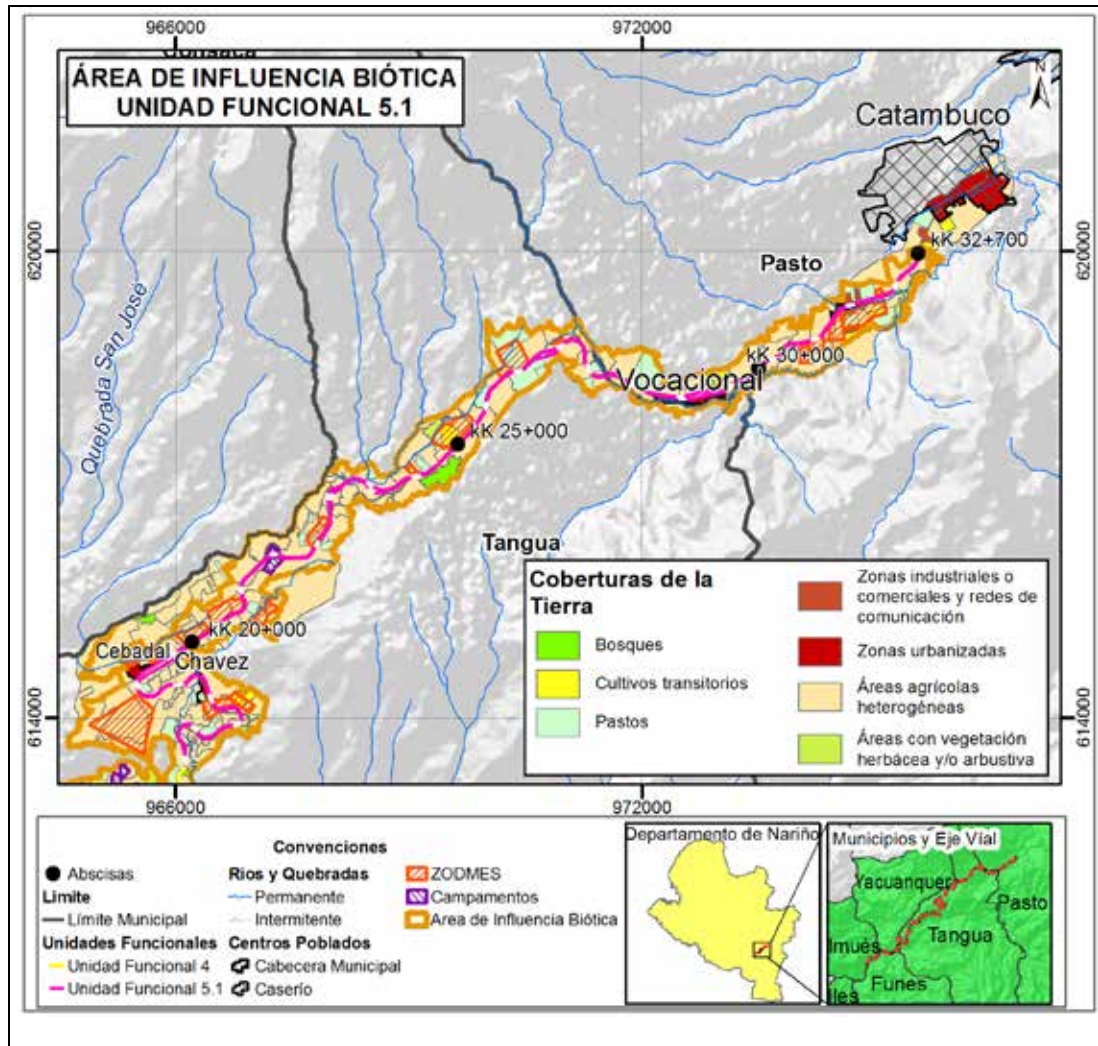



FIGURE 4.14 AREA OF INFLUENCE OF BIOTIC MEDIA– FUNCTIONAL UNIT 5 SUBSECTION 1 OF DOUBLE LANE RUMICHACA – PASTO HIGHWAY PROJECT, PEDREGAL – CATAMBUCO SECTOR

Source (Géminis Consultores Ambientales, 2016)

(See GDB/cartography/PDF/code/ EIADCRP_PC_003.1)

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4.2.3. Physical area of influence –Final Biotic

The biotic-physical area of influence refers to the integration of two media: the biotic and non-biotic areas of influence. For their delimitation, impacts associated to each media and component were taken into account, as well as factors that present modifications over said impacts. According to the former proviso, the physical-biotic area of influence was delimited based on the criteria explained in previous sections of this document, worth saying: coverage units, ecologic connectivity, geomorphological characteristics, geological formations, stability conditions (existing and induced), the limits of water intervene upstream, the boundaries of micro-basins and demarcations established with the help of topography and level curves.

Natural coverage is included as a determinant factor for the biotic component given its relationship with ecological connectivity processes, which allow for flora and fauna to settle, or not, in the area of influence. Soil characteristics are directly linked with existing coverage in the zone. However, both at ground level and at coverage level, the topographic characteristics of the terrain may show variations over the different impacts identified for these components.

In the case of the hydrological component, coverage and use of the ground present and important relationship in the dynamics of water bodies, this due to regulation processes and/or contamination each type of cover could represent over the hydric body. In this sense, it is valid to delimit the hydric component based on coverage directly related to the area of intervention of the project, and in turn, in respect to the water bodies that will be intervened. In those areas where the area of intervention do not cross hydric bodies but that are inside their protection area, they were included in order to identify possible impacts that could affect them, formulating the corresponding management measures.

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This analysis at physical-biotic media was carried out by taking into account each component (hydric – non biotic media and ground cover) and manage it under an holistic approach within the concept of an ecosystem, where in addition to above mentioned components, geology, geomorphology and ground as part of landscape come together, conforming the area to be studied altogether as a result of terrain physiography.

For the double lane Rumichaca – Pasto highway project, Pedregal – Catambuco sector, a total of 1933,62 hectares fall under the physical-biotic area of influence distributed among the municipalities of Imués, Yacuanquer, Tangua and Pasto (see Table 4.6 and Figure 4.15).

The formerly mentioned conditions and criteria impact both the definition of the area of influence as well as the analysis of the areas of interest for the road project, such as the choosing of water capture points, camps sites and selection of zones for ZODME. This procedure always comprise analysis of the geological, geotechnical and hydrological conditions, in such a way that final determinations can help to guaranty the stability of terrains, the natural regime of runoffs, the quality of hydric resources and the overall protection of natural resources.

Additionally, among considerations to determine the ZODME, camp sites, plants, water capture points and all infrastructure associated to the project, a verification takes place to make sure there is no instability on borders of water bodies nor on natural slopes, and also making sure current environmental legislation and regulations are being comply with, including the non-occupation of hydric resource embankments while keeping works away from water sources.

To previous mentioned analysis, on selection of sites of interest (ZODME, water capture points, camp sites, etc) and determination of areas of influence, other analysis are included that follow

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social criteria, as it has been explained for this component, to safe guard distances and implement management plans to protect the interests of families and communities.

TABLE 4.6 PHYSICAL-BIOTIC AREA OF INFLUENCE FOR THE DOUBLE LANE RUMICHACA – PASTO HIGHWAY PROJECT, PEDREGAL – CATAMBUCO SECTOR

Municipality	Physical-biotic area of influence per municipality
Pasto	349,71
Tangua	1290,88
Yacuanquer	165,73
Imués	116,49
Funes	10,82
TOTAL	1933,62

Source: (Géminis Consultores Ambientales, 2016)

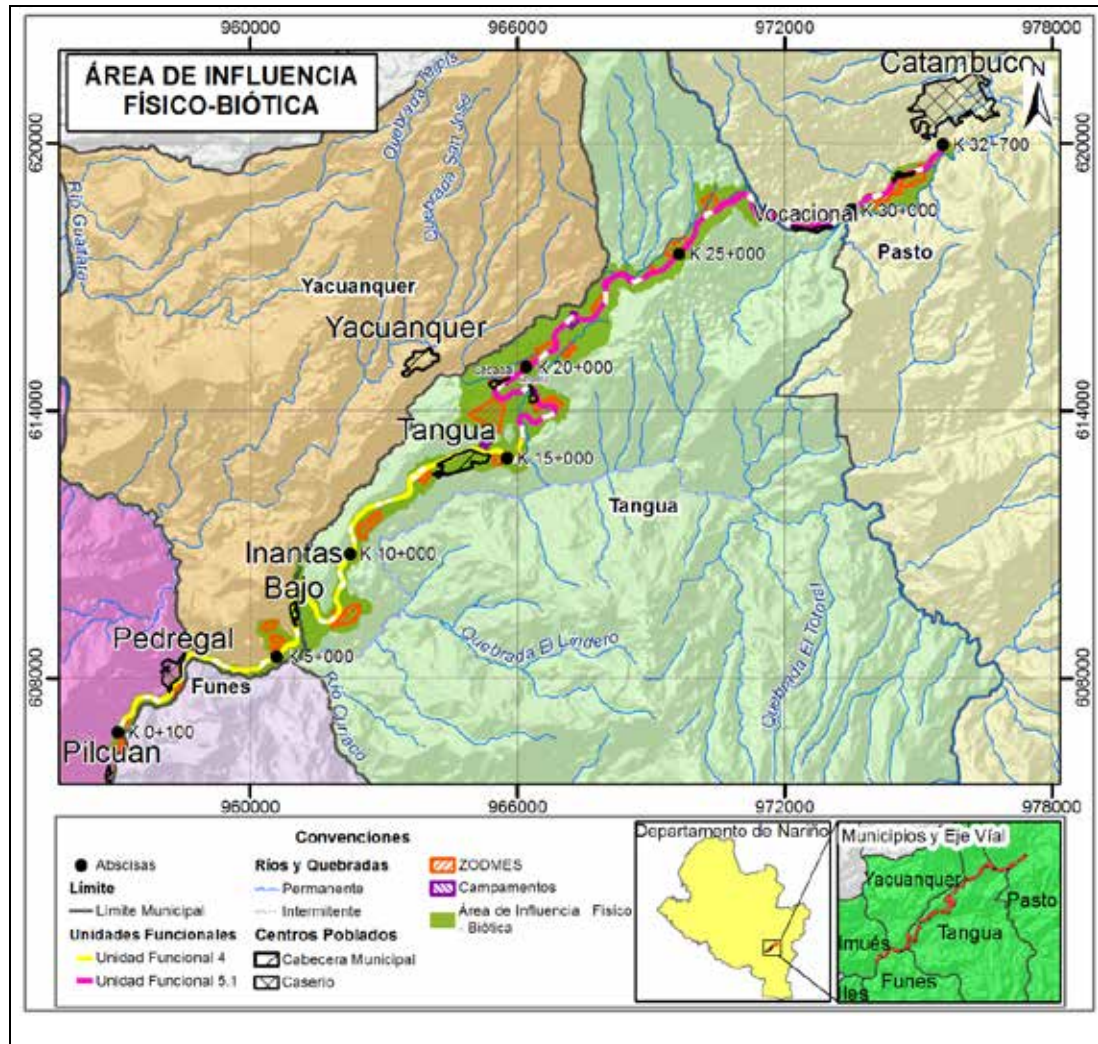



FIGURE 4.15 PHYSICAL-BIOTIC AREA OF INFLUENCE MAP FOR THE DOUBLE LANE RUMICHACHA – PASTO HIGHWAY PROJECT, PEDREGAL – CATAMBUCO SECTOR

Source: (Géminis Consultores Ambientales, 2016)

(See GDB/cartography/PDF/code/ EIADCRP_PC_003.3)

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In Pedregal sector, beginning of Functional Unit 4, the area of influence was determined by the left hand side, south to north course, based on the criteria for coverage, where continuous urban building was included, next to the urban area of Pedregal, and those that are directly intervened by the project. On the right hand size, same direction, the criteria to define the area of influence was hydric, by extending this up to the water mouth of water bodies that cross the project, namely the Bobo and Guaitara rivers. For this last river, the extension went up to the water quality monitoring point, upstream this same river.

The right hand side of area of influence extends to the north following Bobo River up to the point where it merges with La Magdalena water stream, and here the criteria that follows in one of basin going through the water division lines up to when the slope allows to retake the criteria of coverage directly affected by the project.

To the north, Catambuco sector, the predominant criteria for the delimitation of the area of influence was the atmospheric criteria, given that according to the model for dispersion under a scenario of no project, under current allowable limits of 10 PPM, the limit was ended up to the point shown in the figure.

4.2.4. Final Socio-Economic Area of Influence

Pursuant to the terms of reference for the preparation of the Environmental Impact Plan –EIA for road and/or tunnel projects, the areas of influence are defined as per analysis units, which for the socio-economic media correspond to large territorial units (municipalities) and minor

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territorial units, such as the minimum analysis units (townships (C), rural districts (V), Neighborhoods (B)).

Large territorial units are territorial entities at municipal level, being crossed by the project, and therefore where secondary impacts, or impacts of secondary order, are relevant, temporary type and present at all project stages. By virtue of above mentioned proviso, the area of influence where indirect impacts manifest, for Pedregal – Catambuco sector, correspond to functional units 4 and 5.1 of the double lane Rumichaca – Pasto highway, constituted by the municipalities of Imués, Tangua, Yacuanquer and Pasto in Department of Nariño.

When it comes to minor territorial units, predominate relevant primary impacts, or first order impacts, produced on occasion of activities and related works carried out with the construction of road infrastructure, and other associated works such as camp sites, ZODMEs and access roads needed to reach work fronts.

Consequently, the area of influence where direct impacts are shown, for Pedregal – Catambuco sector, is made up of 28 minor territorial units that are part of Imués (2), Yacuanquer (2), Tangua (13) and Pasto (8) municipalities, and three (3) neighborhoods that are part of the municipality of Tangua, all of them listed in Table 4.7 per functional units.

In these minor territorial units predominate disperse rural zones within functional units 4 and 5.1 corridor, exception made of those that correspond to the municipality of Imués that have population centers above 100 inhabitants.


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TABLE 4.7 AREA OF INFLUENCE FOR PEDREGAL-CATAMBUCO SECTOR, ACCORDING TO FUNCTIONAL UNITS, LARGE AND MINOR TERRITORIAL UNITS

Functional Unit	Municipality	Minor Territorial Units
FU 4	Imués	El Pedregal
		Pilcuán
	Yacuanquer	Inantas Bajo
		Inantas Alto
	Tangua	Cocha Verde
		El Tablón Obraje
		San Pedro Obraje
		Barrio Corazón de Jesús
		Barrio Fátima
		Barrio Bolívar
		El Vergel
		Buena Esperanza
		FU 5.1
Chávez		
El Tambor		
El Páramo		
La Palizada		

Functional Unit	Municipality	Minor Territorial Units
		Marqueza Bajo
		Los Ajos
		Marqueza Alto
	Pasto	Gualmatán Alto
		Vocacional
		Cubijan Alto
		Cubijan Bajo
		La Merced
		San José de Catambuco
		Catambuco
		Huertecillas

Fuente: (Géminis Consultores Ambientales, 2016)

Figure 4.16 and Figure 4.17 below, illustrate the area of influence for the double lane Rumichaca – Pasto highway project, Pedregal – Catambuco sector, for each functional unit.

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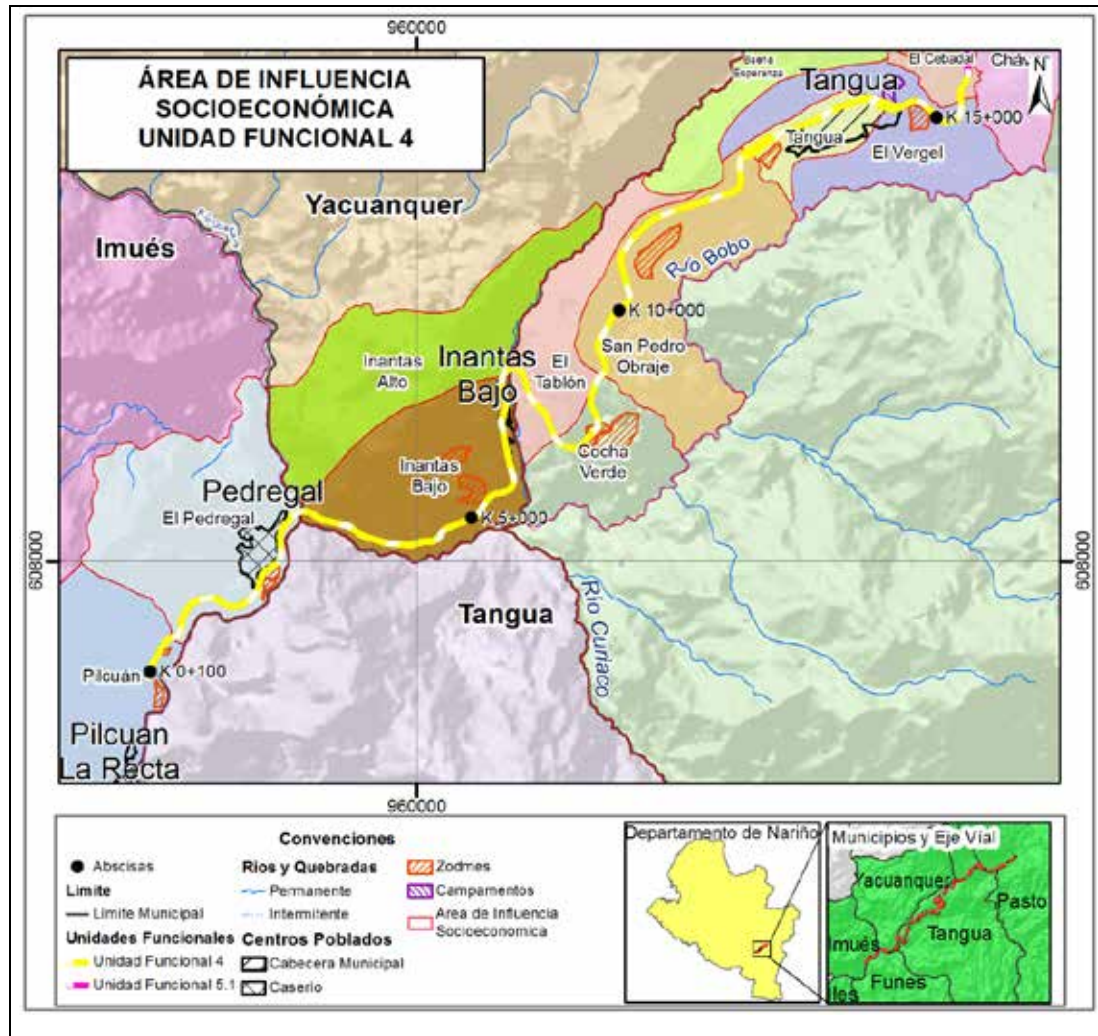



FIGURE 4.16 SOCIO-ECONOMIC AREA OF INFLUENCE, FUNCTIONAL UNIT 4 OF THE DOUBLE LANE RUMICHACA – PASTO HIGHWAY PROJECT, PEDREGAL – CATAMBUCO SECTOR

Source: (Géminis Consultores Ambientales, 2016)

(See GDB/cartography/PDF/code/ EIADCRP_PC_013)

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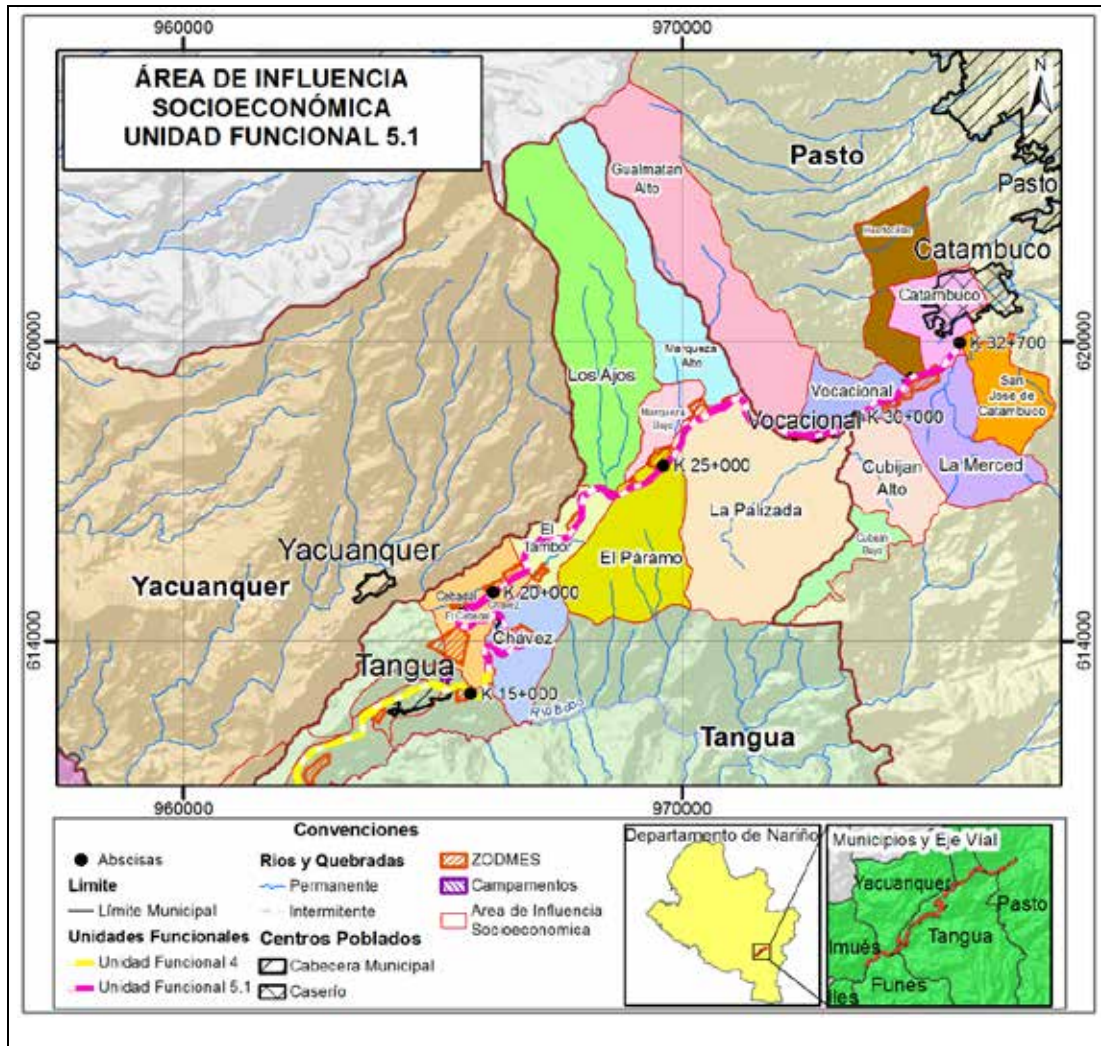



FIGURE 4.17 SOCIO-ECONOMIC AREA OF INFLUENCE, FUNCTIONAL UNIT 5, SUBSECTION 1, DOUBLE LANE CALZADA RUMICHACA – PASTO HIGHWAY PROJECT, PEDREGAL – CATAMBUCO SECTOR

Source: (Géminis Consultores Ambientales, 2016)

(See GDB/cartography/PDF/code/ EIADCRP_PC_013)

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4.2.5. Area of intervention of the double lane Rumichaca – Pasto highway, Pedregal – Catambuco sector

The area of intervention corresponds to the overlapping of the areas of the different components that are necessary to execute the project. Within these, it is possible to find the road layout, the right to road, the replacement of existing access roads, camp sites, m ZODME, access roads and water capture points for the project. A safety buffer was given to each component, ranging from 5 to 10 meters in order to provide for adjustments at geometric level, given that the design over which this study is based on correspond to Phase II of the project (Feasibility Phase) as it is mentioned in the terms of reference for the preparation of the environmental impact studies (Resolution 0751 of 2015).

Starting from the integration of the areas part of the different project components, the overlapping areas for the road project were defined obtaining at the end a single polygon that comprise all components plus a safety margin.

For Pedregal-Catambuco sector, the double lane layout has a longitude of approximately 32.7 km, the right to road, 33 areas for ZODME, 16 access roads, 2 camp sites and 5 water capture points for a total of 482,49 hectares that constitute the area of intervention.

Figure 4.18 and Figure 4.19 below, show graphically the double lane road project’s area, Rumichaca – Pasto, Pedregal – Catambuco sector, for the two functional units that are part of this sector.

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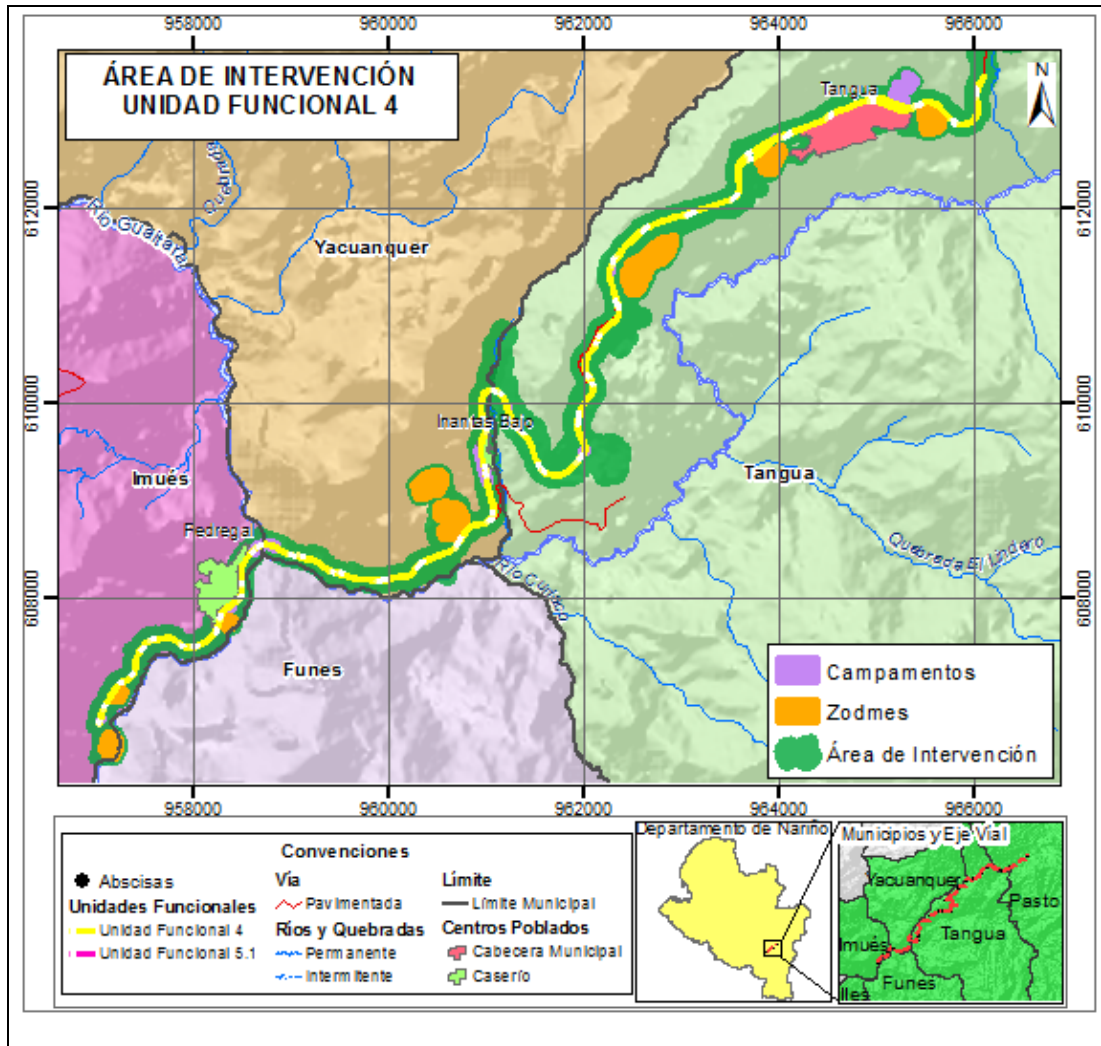



FIGURE 4.18 AREA OF INTERVENTION, DOUNEL LANE RUMICHACA – PASTO HIGHWAY PROJECT, PEDREGAL – CATAMBUCO SECTOR, FUNCTIONAL UNIT 4

Fuente: (Géminis Consultores Ambientales, 2016)

(See GDB/cartography/PDF/code/ EIADCRP_PC_016)

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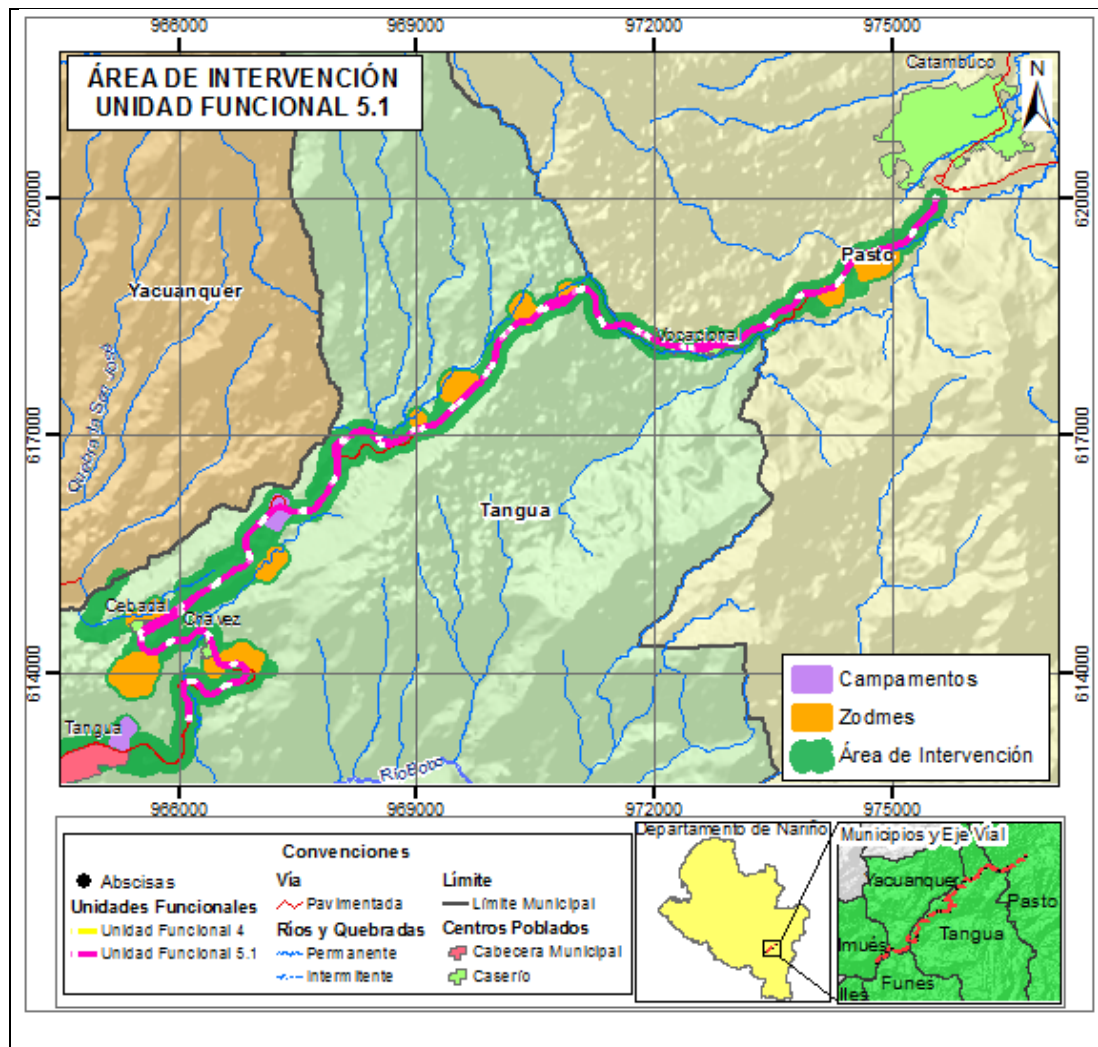



FIGURE 4.19 AREA OF INTERVENTION, DOUBLE LANE RUMICHACA – PASTO HIGHWAY PROJECT, PEDREGAL – CATAMBUCO SECTOR, FUNCTIONAL UNIT 5, SUBSECTION 1


Source: (Géminis Consultores Ambientales, 2016)

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SECTOR, FU 4 AND FU 5,1, CONCESSION CONTRACT UNDER PPA SCHEME N°. 15 OF 2015

(See GDB/cartography/PDF/code/ EIADCRP_PC_016)

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