



**Nudo del Azuay Conservation Initiative:  
An Introduction to the Dudas Watershed**



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August 2008

## Table of Contents

List of Figures and Tables.....	3
Introduction.....	4
Political Geography .....	5
Physical Geography .....	5
Hydrology .....	5
Climate.....	6
Slope .....	6
Human population, settlement, cultural affiliation and land tenure.....	9
Land Use and Land Cover Change .....	11
Queseras subwatershed .....	15
Threats .....	15
Socio-economic conditions.....	17
Middle Dudas.....	17
Queseras.....	17
Infrastructure.....	18
Organization and Leadership .....	18
Conclusion .....	19
Bibliography of references cited.....	20

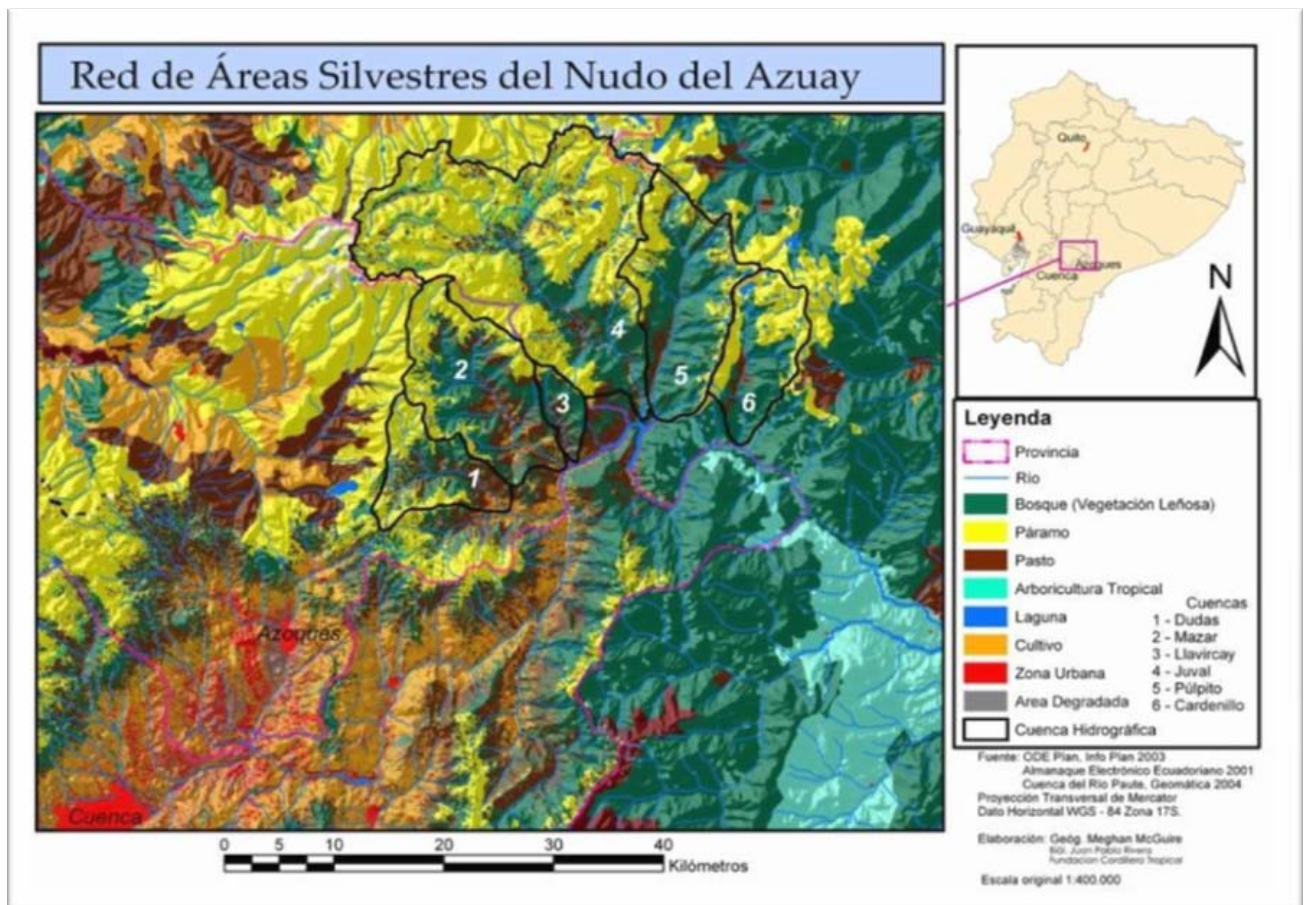
## List of Figures and Tables

Figure	Page
<b>Figure 1:</b> Six contiguous watersheds form the Nudo del Azuay conservation area: Dudas(1), Mazar(2), Llavircay(3), Juval(4), Púlpito(5) and Cardenillo (6)	4
<b>Table 1:</b> General Hydrologic Parameters of the Dudas and Mazar Watershed	5
<b>Figure 2:</b> Rio Paute watershed with Dudas watershed outlined in red	6
<b>Figure 3:</b> Map of slopes in the Dudas watershed	7
<b>Figure 4:</b> Hydrology and Relief in the Dudas Watershed	8
<b>Table 2:</b> Human population by region in the Dudas watershed	9
<b>Figure 5:</b> Queseras Community Area within the Dudas Watershed	10
<b>Figure 6:</b> San Antonio de Dudas community area within the Dudas Watershed	11
<b>Table 3:</b> Dudas Watershed Land Use and Vegetation Cover	12
<b>Figure 8:</b> Land Use and Vegetation Cover in the Dudas Watershed	13
<b>Figure 9:</b> Nudo del Azuay (in yellow outline) with ABVP #15 (cross-hatching) and Sangay National Park (in darker green). The Dudas watershed is located at the southernmost limit of the Nudo del Azuay	14
<b>Table 4:</b> Queseras Subwatershed Land Use and Vegetation Cover	15
<b>Figure 10:</b> Changes in Vegetation Cover, Nudo del Azuay, 1991-2001	16

## Introduction

The Dudas watershed forms the southernmost edge of six contiguous watersheds within the Nudo del Azuay, a region spanning 100,000 hectares of immense biological, hydrological and cultural importance. The mountainous knot links the eastern and western *cordilleras* in southern Ecuador and includes the neighboring Mazar, Llavircay, Juval, Pulpito and Cardenillo watersheds (Figure 1). Well-preserved and biologically-diverse tropical montane forests and páramos ecosystems dot the Nudo del Azuay which is part of the Tropical Andes hotspot, an area of extreme biodiversity with a high risk for further degradation. The area is located within Sangay National Park and forms the upper watersheds of the Paute River, a source of hydroelectricity for all of Ecuador. In addition to the vast biological and hydrological importance, the region also hosts a vast array of archaeological sites, testimony to a Cañari cultural landscape disarticulated by the Inca conquest after 1460 and the Spanish conquest in 1532. Despite its location within a national park and its globally rare biodiversity, this important biological and cultural heritage within the Dudas watershed is threatened by an encroaching road network as well as the expansion of the agricultural frontier.

**Figure 1:** Six contiguous watersheds form the Nudo del Azuay conservation area: Dudas(1), Mazar(2), Llavircay(3), Juval(4), Pulpito(5) and Cardenillo(6).



Source: Meghan McGuire and Juan Pablo Rivera, 2005 (Fundación Cordillera Tropical)

## Political Geography

The Dudas watershed is located in Pindilig Parish, Azogues Canton, Province of Cañar. It borders the parishes of Rivera (to the north), Ingapirca (to the west), and Taday (to the south). Within the Pindilig Parish, the Dudas watershed occupies approximately 85% of the total area.

In 2006, the Pindilig parish had a total population of 2,262 inhabitants<sup>1</sup>. As compared to other areas of the Ecuadorian Sierra, population densities are moderate to low in the Dudas watershed. However, like several of its southern homologues, the population of the Dudas watershed is only 46% male, whereas 54% of the total population is female, a reflection of high migration rates for males.

## Physical Geography

### *Hydrology*

The Dudas watershed is a small part of the much larger 5,186 square kilometer Paute watershed whose hydroelectric generation provides power for much of the country (Figure 2). The Dudas watershed is a headwater valley which feeds the Amazon. The watershed occupies 8,328 hectares which drain from west to east. Its western limits correspond to the continental divide at 3,780 m of elevation while it descends to 2,480 m at the Quebrada San Pedro, its easternmost limit. Basic parameters of Dudas watershed hydrology reflect an area of high rainfall, limited seasonality, steep terrain and intermediate levels of human land-use alterations (Table 1).

**Table 1:** General Hydrologic Parameters of the Dudas and Mazar Watersheds

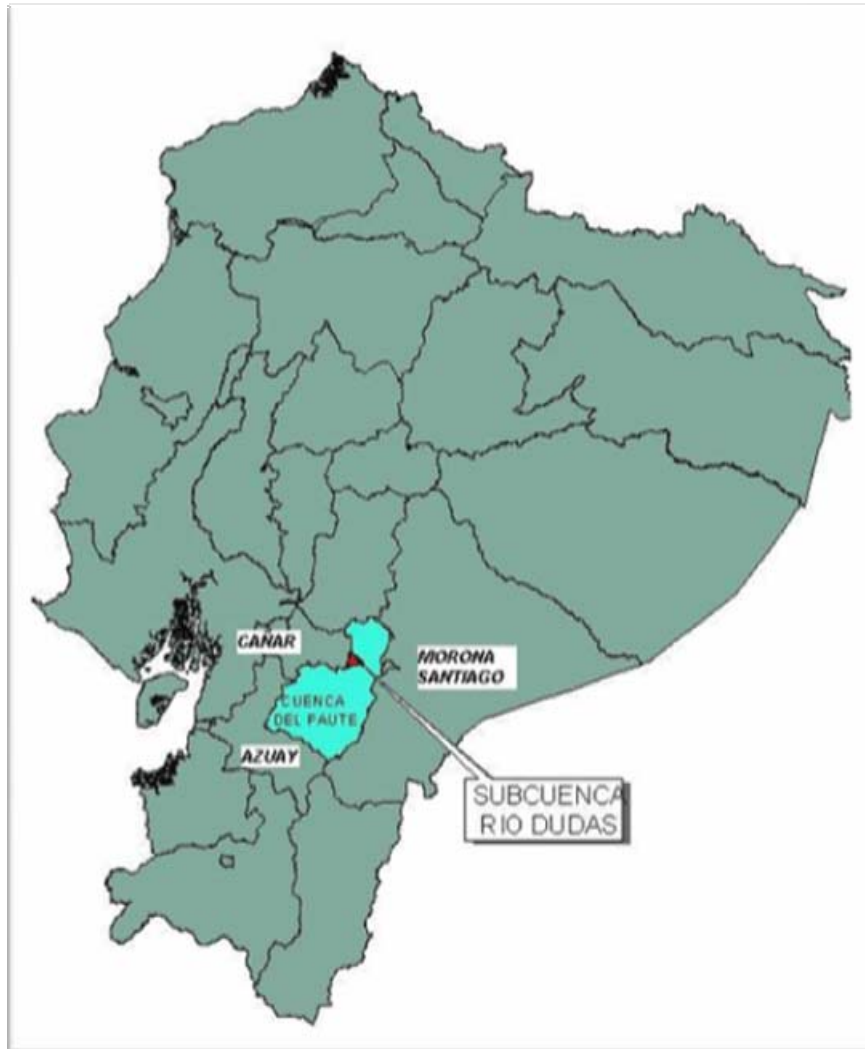
<b>Variable</b>	<b>Dudas</b>	<b>Mazar</b>
<b>Sediments</b>	30.9 metric tons/year/km <sup>2</sup>	18.8 metric tons/year/km <sup>2</sup>
<b>Runoff coefficient</b>	0.46	0.87
<b>Average flow</b>	3.05 m <sup>3</sup> /second	5.05 m <sup>3</sup> /second
<b>Specific flow (<i>caudal específico</i>)</b>	21.4 liters/second/km <sup>2</sup>	31.9 liters/second/km <sup>2</sup>

Source: Empresa Eléctrica de Azogues (EEA) and PROMAS/Universidad de Cuenca, nd [ca.2007], "Informe Final: Estudios de Prefactibilidad de las Centrales Hidroeléctricas de Llavircay y Dudas"

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<sup>1</sup> The urban populace of Pindilig is contemplated within this population estimate.

**Figure 2:** Rio Paute watershed with Dudas watershed outlined in red



Source: EcoHomode, 2005, *Gestión Ambiental y Plan de Acción de Manejo, Subcuenca del Río Dudas* (ProBona, Fundación Sela, Ministerio del Ambiente).

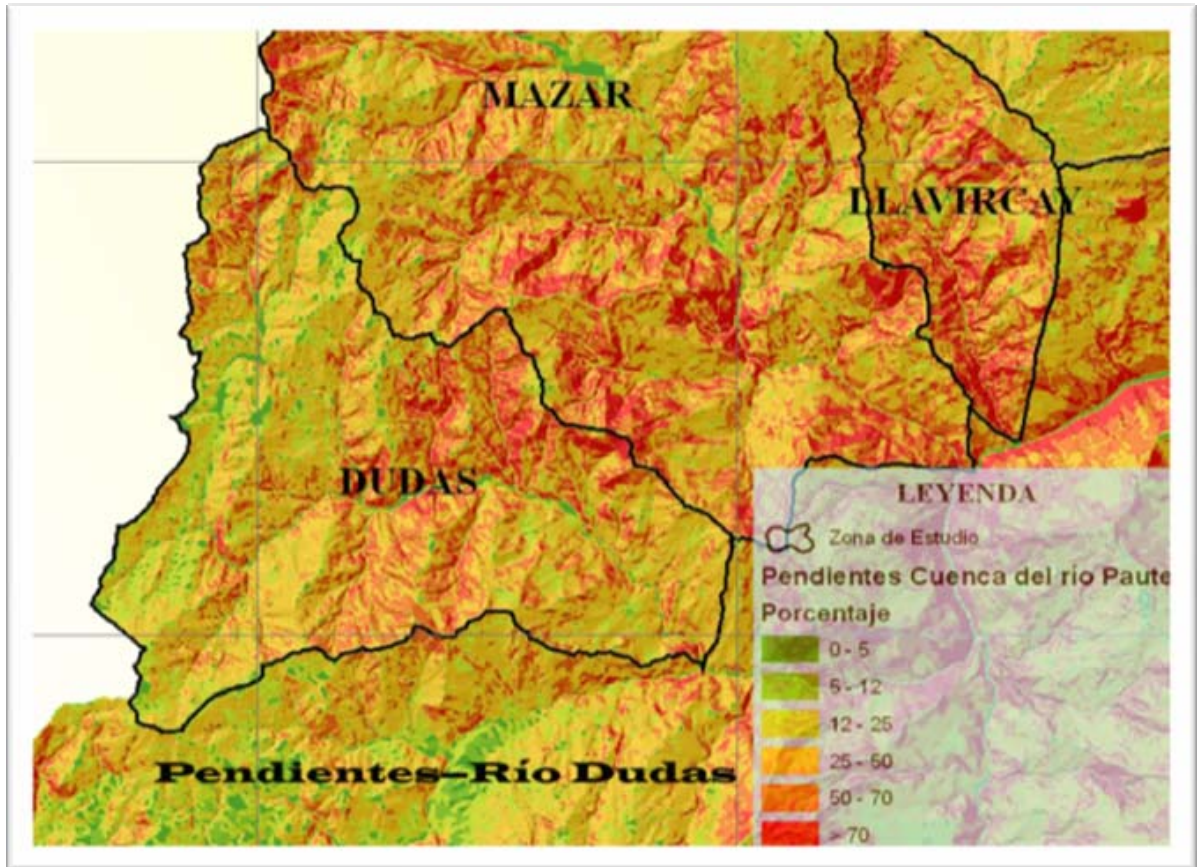
### *Climate*

Climate in the Dudas watershed is cool and wet year-round. At the top of the watershed, annual average temperature is 11<sup>0</sup> C with 1600 mm precipitation per year. Mid-valley average temperatures are higher, 18<sup>0</sup> C, with an average of 1200 mm precipitation per year. The area has two distinct seasons: the dry seasons which begins (most years) in October/November and extends through January-February, and the wet season. Generally, the wettest months are June, July and August.

### *Slope*

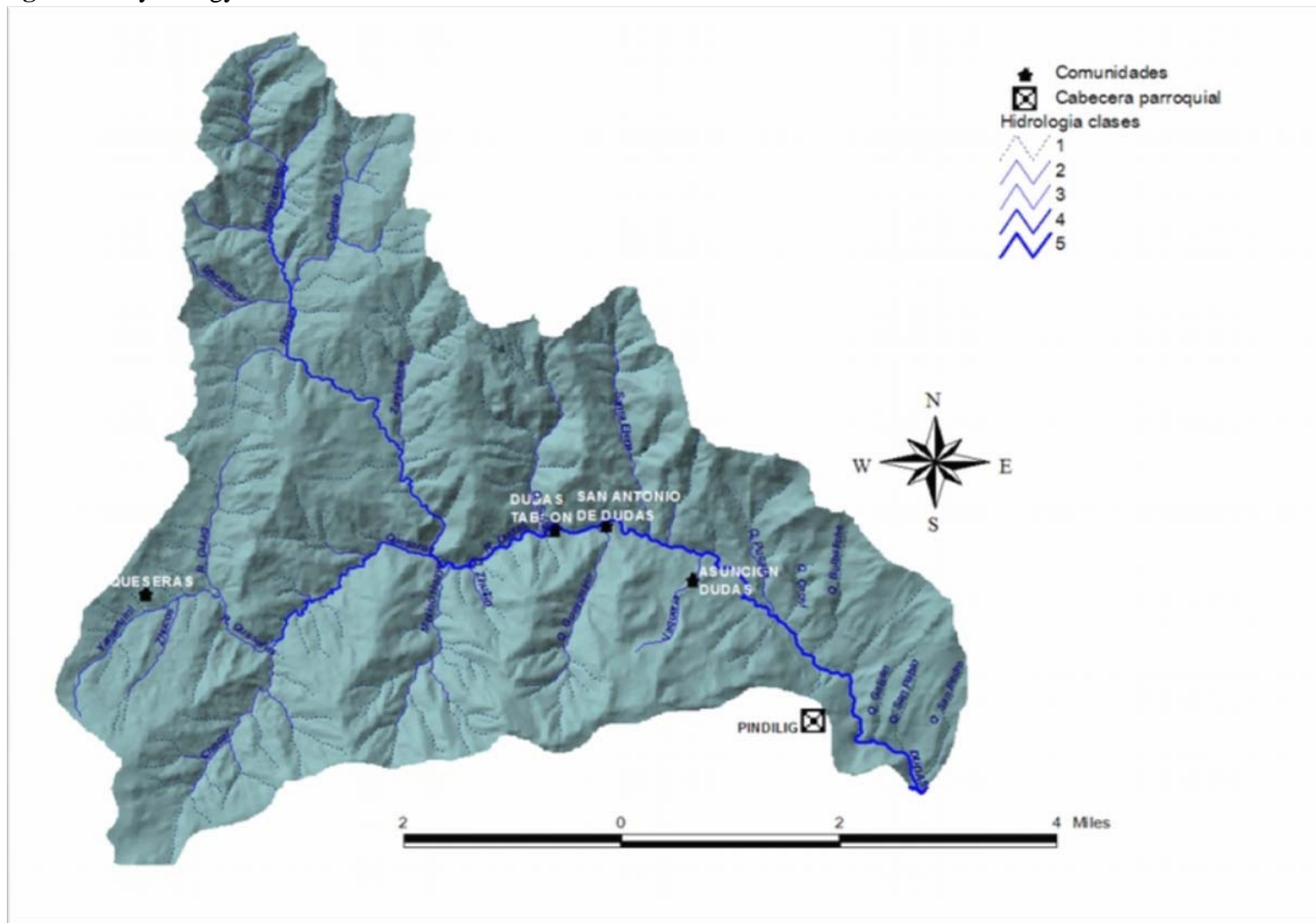
Terrain is rugged, especially in the mid-watershed, where most slopes measure 50-70% or greater. The mildest slopes are located in the southwestern uplands (Figures 3 and 4).

**Figure 3:** Map of slopes in the Dudas watershed



Source: Juan Pablo Rivera, 2007 (Fundación Cordillera Tropical)

**Figure 4:** Hydrology and Relief in the Dudas Watershed



Source: EcoHomode, 2005, *Gestión Ambiental y Plan de Acción de Manejo, Subcuenca del Río Dudas* (ProBona, Fundación Sela, Ministerio del Ambiente).

## Human population, settlement, cultural affiliation and land tenure

Four distinct settlement zones can be identified within the Dudas watershed: Queseras, San Antonio de Dudas, Pindilig, and the unoccupied Northwest sector. Although settlement is dispersed, two moderately nucleated communities can be identified: Queseras and San Antonio de Dudas, the latter including the nearby Dudas Tablón y Asunción Dudas (Table 2).

**Table 2:** Human population by region in the Dudas watershed.

Settlement Zone	Area (hectares)
Queseras	1,939
San Antonio de Dudas	4,383
Pindilig	~906
Northwest	~1,100
<i>Total</i>	8,328

Source: Adapted from EcoHomode, 2005, *Gestión Ambiental y Plan de Acción de Manejo, Subcuenca del Río Dudas* (ProBona, Fundación Sela, Ministerio del Ambiente).

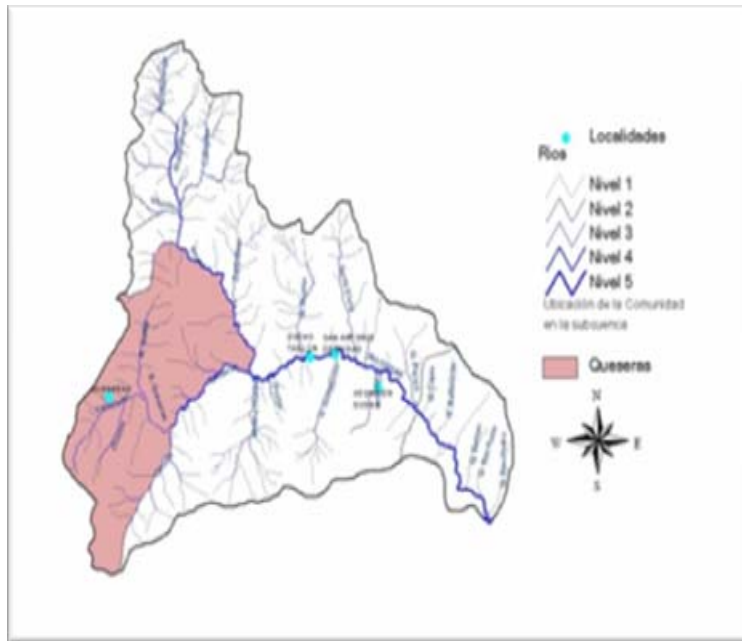
*Queseras* is a 1,330 hectare indigenous community located in the southwest corner of the Dudas watershed (Figure 5). A 1980 Ministerial Decree<sup>2</sup> established the community which is officially known as “Cooperativa de Producción Agrícola Virgen de la Nube”. The total land area includes a large contiguous, collectively-owned area as well as some privately-owned land. However, a large area remains in dispute with the neighboring Huayrapongo Cooperative.<sup>3</sup> Despite the collective ownership, within the Queseras Cooperative proper, the majority of the original acquisition has been divided into lots and assigned individually. Today, 72 families own the cooperative, an increase from the 30 founding families in 1980. The majority of founding members speak Quichua; however, the younger generation speaks primarily Spanish.

Historically, a largely self-sufficient community with weak ties to markets and minimum involvement with communities outside the watershed, out-migration over the past 15 years has radically changed this once-insular community. Today, many residents have one or more relatives living in the United States or Europe. A corresponding increase in remittances has allowed local families to intensify the conversion of native páramo to artificial pasture, to buy vehicles for personal use or for local commercial transport, and to invest in housing and education in Azogues, the provincial capital.

<sup>2</sup> Ministry of Agriculture, Decree 086, March 13, 1980.

<sup>3</sup> EcoHomode, an Azogues-based conservation and development organization that has worked in the Dudas watershed, advocates the Queseras position in the dispute, as reflected in the ‘Queseras Community’ map. Nonetheless, Huayrapongo occupies all of the disputed lands.

**Figure 5:** Queseras Community Area within the Dudas Watershed



Source: EcoHomode, 2005, *Gestión Ambiental y Plan de Acción de Manejo, Subcuenca del Río Dudas* (ProBona, Fundación Sela, Ministerio del Ambiente)

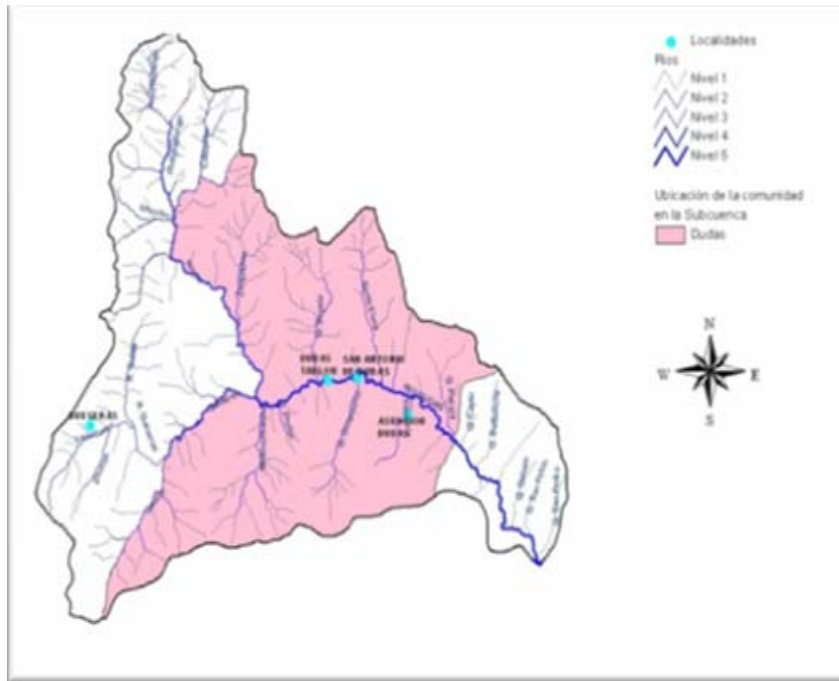
*San Antonio de Dudas* is a dispersed mestizo community centered upon the primary school and chapel located at San Antonio de Dudas in the middle valley (Figure 6). Outmigration from the parish of Luis Cordero (near Azogues) led to the formation of the Dudas community during the 1960s and 1970s. At this time, medium to small landholders replaced the haciendas that had been established in the late 19<sup>th</sup> and early 20<sup>th</sup> centuries. Today, most residents have obtained legal land title to farms ranging in size from 10 and 40 hectares, while at least five farms are between 80 and 400 hectares<sup>4</sup>. An underclass of landless and small-holding residents exists in the middle Dudas.

We estimate that a total of 70 families reside in the middle Dudas. However, many of these families are part-time residents, with one foot in Dudas and another in Azogues, Cuenca or abroad. FCT is in the process of finishing a detailed socio-economic study of the Dudas watershed which will provide a more accurate picture of population and migration patterns.

For over a generation, the Dudas community has been tightly tied to regional markets. It is common that residents have relatives living in nearby communities, Azogues and even abroad. As such, these community members are well-versed in economic and educational opportunities elsewhere. Many receive remittances from relatives who work abroad. International migration has been accompanied in recent years by an intensification of out-migration to Azogues and Cuenca, with the result that population in the middle Dudas is declining. In the year 2000, the elementary school had over 40 students, and now has fewer than 20 students.

<sup>4</sup> Landowners with more than 40 hectares include Rafael Heredia, Ana Brito, Luis Heredia, Stuart White and José Miguel Peralta.

**Figure 6:** San Antonio de Dudas community area within the Dudas Watershed



Source: EcoHomode, 2005, *Gestión Ambiental y Plan de Acción de Manejo, Subcuenca del Río Dudas* (ProBona, Fundación Sela, Ministerio del Ambiente)

**The Northwest Sector** includes two large indigenous cooperatives, Huayrapongo and Colepato. IERAC granted these two cooperatives land title in the late 1970s. The total territory of these cooperatives within the Dudas watershed includes only 1,100 hectares; however, each cooperative is considerably larger and occupies land in neighboring watersheds. Both cooperatives have divided much of their original communal holdings into even-sized lots assigned to cooperative members. Nevertheless, most owners have not developed their lots and the majority remain unfenced. It is not clear if the lots are individually titled and registered.

**The Pindilig Sector** covers approximately 900 hectares along both slopes of the lower southeast corner of the Dudas watershed. The region is primarily pasture, with annual crops and fruit trees at the lower elevations. Plot sizes are generally smaller than in the middle Dudas or Queseras regions. In this sector, pasture and cropland have replaced native vegetation.

### Land Use and Land Cover Change

The Dudas watershed is a patchwork of agricultural areas interspersed with remnant montane forest patches in all but the Pindilig sector (Figure 8 and Table 3). Montane forests and páramos remaining in Dudas form the southern extreme of a larger mass of native vegetation extending north into the Mazar, Juval, Pulpito and Cardenillo drainages. Deforestation in the middle Dudas has begun near the river and proceeded upslope. However, in many cases conversion to agriculture did not follow the initial deforestation. Today, large areas are covered in shrubby secondary forest which now represents over a

quarter of the watershed's vegetative cover. The area's páramos are heavily degraded in the southwest uplands of the Dudas watershed, but well preserved in the northwest.

**Table 3:** Dudas Watershed Land Use and Vegetation Cover

<b>Current Land Use</b>	<b>Area (ha)</b>	<b>Percentage</b>
Native Forest	1499,84	18,01
Shrub and secondary	2286,57	27,46
Páramo	2457,94	29,51
Pasture and páramo	248,61	2,99
Pasture	1442,85	17,32
Crops	243,84	2,93
Pine Plantation	147,96	1,78
Lakes	0,63	0,01
<b>TOTAL</b>	<b>8328,24</b>	<b>100</b>

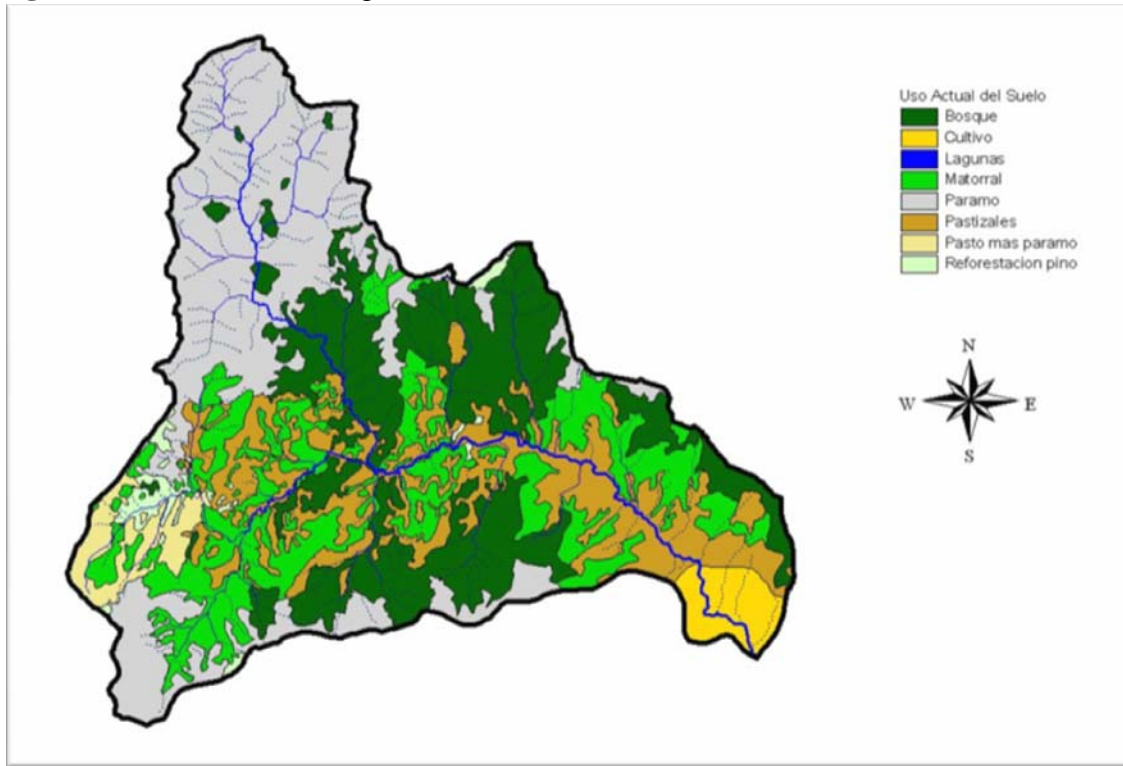
Source: EcoHomode, 2005, *Gestión Ambiental y Plan de Acción de Manejo, Subcuenca del Río Dudas* (ProBona, Fundación Sela, Ministerio del Ambiente).

These forests and páramos have strategic value because their river systems contribute to the Paute-Molino hydroelectric project, and will soon contribute toward the Paute-Mazar and subsequently Paute-Sopladora projects. The proximity of these watersheds to the Paute hydroelectric system further augments their importance: additional river sediments produced by land use changes will be transported to downstream reservoirs.

In recognition of the extraordinary biological and hydrological importance of the Nudo del Azuay (including the Dudas watershed), the Ecuadorian state through subsequent declarations sought to protect the area indefinitely from further degradation. Beginning in 1985 then national electric authority, INECEL, secured the *Area de Bosque y Vegetación Protectora* (ABVP) designation for the Dudas and neighboring watersheds to the north (Figure 9). By 1992 the Ministry of Agriculture, INEFAN, (a precursor to the Ministry of the Environment) decreed a 250,000 hectare expansion of Sangay National Park which stretches south to the Santa Elena and Sarapampa Rivers and includes the forested northern slope of the middle Dudas. The decree recognized the right of landowners with title before May 20, 1992 to retain their ownership rights within the new national park (presumably including the right to buy and sell; however, the decree prohibited new assignments of untitled land). Initial observations suggest that almost all of the current residents of the north slope of the middle Dudas had title before 1992, and thus are legal in-holders of the Park.

Within the Dudas watershed, 5,225 hectares are located within the ABVP Dudas, Mazar, Llavircay, Juval y Pulpito #15 (hereafter ABVP #15). Nearly 2,556 hectares of the ABVP #15 overlaps in area with the 1992 extension of Sangay National Park. However, in spite of the assignment of these lands as a national park, the expansion has had very limited impact on land use. In fact, only within the last two years have authorities placed signs to indicate park borders. To date, the ABVP designation has little influence over land use change, but may provide conservation leverage if/when a local conservation interest exists (e.g., a municipality wishes to protect its water supply).

**Figure 8:** Land Use and Vegetation Cover in the Dudas Watershed



Source: EcoHomode, 2005, *Gestión Ambiental y Plan de Acción de Manejo, Subcuenca del Río Dudas* (ProBona, Fundación Sela, Ministerio del Ambiente).



### *Queseras subwatershed*

Prior to agricultural intensification, the Queseras subwatershed was primarily grass páramo interspersed by native forest patches. However, current land users have greatly modified the existing landscape to allow for increased cattle ranching (Table 4).

**Table 4:** Queseras Subwatershed Land Use and Vegetation Cover

<b>Current Land Use</b>	<b>Area (ha)</b>	<b>Percentage</b>
Native Forest	127,5	6,58
Shrub and secondary	477,57	24,63
Páramo	645,56	33,29
Pasture and páramo	248,13	12,80
Pasture	332,13	17,13
Pine Plantation	108,09	5,57
<b>TOTAL</b>	<b>1938,98</b>	<b>100</b>

Source: EcoHomode, 2005, *Gestión Ambiental y Plan de Acción de Manejo, Subcuenca del Río Dudas* (ProBona, Fundación Sela, Ministerio del Ambiente).

### *Threats*

Though locally variable, deforestation continues to threaten the Dudas watershed's forests and páramo plant communities (Figure 10). Current deforestation pressures are highest on the southern slope of the middle Dudas and along the Sarapampa River. The latter is held by the Huayrapongo Cooperative as well as a small number of individual owners. Deforestation rates are lower in the middle Dudas on the north slope, in partial function of its status as a national park but primarily, in our judgment, because landowners have other more attractive economic options.



## Socio-economic conditions

### *Middle Dudas*

Most of the deforested lands in the middle Dudas are currently in pasture, on which dual-purpose cattle are kept. Milk provides a modest daily income<sup>5</sup> while the sale of bulls and occasionally cows generates larger sums (\$150-\$250 per head). When inquiring among local residents about the source of most income, the universal response is “cattle” or “milk”. Other cash income is derived from the production of potatoes and peas. Since 2007 there has been a marked increase in prices paid for potatoes in this region. Corn, melloco, beans and squash are planted for home consumption.

Forests are used for the production of timber and non-timber forest products. Some forests are used to extract the duda cane (*Aulonemia queko*), which is sold in bulk to middlemen who resell the cane to basket makers in the Cuenca area. The other forest-derived income in Dudas arises from the production of charcoal. Producers burn the understory woody vegetation of the native forests to produce charcoal. Recently, owners have sold the “charcoal rights” to outside intermediaries. In this scheme, the intermediary pays the landowners a fee and later converts all small woody vegetation to charcoal. Middlemen purchase the charcoal and resell it in Cuenca and Azogues, often to rotisserie chicken restaurants. In recent years, however, the interest and extraction of charcoal have diminished considerably. We are not clear if the reduced charcoal production reflects market prices, the unavailability of the wood resource, or conservation efforts within the community.

Non-native pine plantations (almost exclusively of *Pinus radiata*) cover less than 1% of the middle Dudas watershed. To date, these pines have not been commercially harvested, but some have been converted to charcoal.

### *Queseras*

As a government-sponsored cooperative, Queseras was the recipient during the 1980s and 1990s of considerable attention and assistance by government and non-government institutions. Projects included the improvement of road access, provision of a tractor, pasture inputs, technical assistance and pine saplings to establish plantations. In addition, remittances have permitted personal investments in agriculture, road access, and housing. The landscape transformation over the last twenty years has been profound. Intensive milk production has replaced a formerly extensive meat cattle system; páramo grasslands have been plowed, fertilized with chicken manure and planted in exotic pasture species; woodlands have been harvested for firewood and fences. It is notable that the area dedicated to subsistence production (potatoes, mellocos, haba beans) has diminished as cash incomes from cattle and remittances have increased.

Currently, as with the middle Dudas, the majority of income derives from milk and beef production. Some charcoal has been produced using pines, but the market has discounted pine-derived charcoal because it is a less concentrated heat source than native hardwoods. The cooperative itself and some individual owners have recently begun to sell their standing pine plantations (of 15-20 years' growth) to commercial wood companies, specialized in making palette pieces from the undersized pines. For a 15 year-old plantation in good condition, buyers are paying \$400-\$600/hectare (about \$0.50 per tree).

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<sup>5</sup> As of June, 2008, farmers are paid US\$0.28 per liter, an increase of 50% over prices paid a year before. An average cow may produce 3 liters of milk per day for 5 months. On steep pastures without fertilization, a stocking rate of one cow per hectare is the norm.

In Queseras, a native fern, *yashipa*, is harvested from the páramo. A horse-load of *yashipa* is sold for about US\$6 to trucks that come from the Coast on specified days. The ferns are then resold to flower shops and cemetery outlets in Guayaquil.

## Infrastructure

A gravel road follows the course of the Dudas River on the southern margin, connecting with the major road between Azogues and Rivera. This road, which has existed for over 35 years, initially allowed for the export of charcoal and more recently, access to milk markets. In 1982, the state improved the road to permit the construction of high-voltage power lines and towers that conduct electricity from the Paute-Molino hydroelectric complex.

Queseras, a strategic link during the construction of the Paute-Molino, has been linked by gravel road to the Azogues-Rivera artery for the past 30 years. For most of the past two decades use has been limited. Today the increased milk production coupled with travel by Queseras residents in their personal vehicles has greatly increased traffic flow. In 2005 the Cañar Provincial government (*Consejo Provincial*), which is responsible for creating and maintaining rural roads, reconstructed and graveled a link between Queseras and Dudas. There is now a market-day bus service from Queseras to the parish town of Pindilig on Fridays which has facilitated the integration of mestizo culture in Queseras.

Cell phone communication is now possible from many points on the western edge of the Dudas watershed, and from high points on ridges above the middle Dudas. Residents have solicited an additional retransmission tower to permit a signal to reach most of the valley.

Primary schools are located in Queseras and San Antonio de Dudas. Student populations are stable in Queseras but, as mentioned, descending in Dudas. No health services are available in the Dudas watershed; residents go to the government's *Centro de Salud* in Pindilig or to a hospital or private clinics in Azogues.

## Organization and Leadership

There is no overarching organization or leadership structure in the Dudas valley. Theoretically the **Junta Parroquial** in Pindilig has this function, but most residents are disengaged from the Junta and pay little heed to its activities. The **Tenencia Política**, represented by the *Teniente Político*, also has jurisdiction over the entire watershed, and settles minor disputes and transgressions. Typically, the *Teniente* may organize communal workdays, to clear a landslide on the road, for example, but has limited influence or incentive to develop long-term community projects.

Of the *three indigenous cooperatives* in the Dudas watershed, Colepato and Queseras are cohesive and capable of formulating and sustaining a work plan. Huayrapongo is large and was once a powerful regional presence, but currently is in a process of disintegration and privatization. Nonetheless, members band together effectively to accomplish specific goals, especially when passions are aroused. This has been the case with the land claim by Queseras. Each of these three cooperatives has an annually-elected directorate, communal enterprises and finances, and periodic group work obligations.

Locally in Dudas, two organizations exist that have organized a variety of development and conservation initiatives: The *Comité de Padres de Familia* and the ‘*Comuna*’ de Dudas<sup>6</sup>. Both are broadly representative, but their functionality depends on the leadership abilities of those in charge, and well as on the support provided by the school teachers or outside non-governmental organizations (NGOs). As of July 2008, Dudas residents participate in no long-term activities. A very strong and well-respected community leader is José Miguel Peralta “Michael”. He has recently returned from the United States where he holds citizenship. His father, also José Miguel Peralta, serves currently as head of the ‘Comuna’.

**The parish priest** provides leadership, both individually and in conjunction with broader initiatives in the eastern parishes of the Azogues Cantón.

**Sangay National Park**, represented by Ingeniero Rafael Guaraca, has had a minimal presence, but as indicated above has started to place park boundary markers in addition to the designation of a small number of neighbors as honorary park guards.

**State organizations** including the Consejo Provincial and Municipio de Azogues have been most active, primarily in road construction and maintenance, but also in creating community infrastructure (schools, meeting spaces, sports facilities). Centro de Reconversión de Azuay, Cañar y Morona Santiago (CREA), a regional development organization, has carried out a variety of short-term development projects. Hidropaute has made specific contributions, especially of pines for afforestation.

**Non-governmental organizations** (NGOs) including Fundación Nuevos Horizontes and Fundación EcoHomode, with Plan Internacional (Foster Parents Plan), have worked in the past in the middle Dudas or Queseras. Currently, Fundación Cordillera Tropical (FCT) has a presence in the middle Dudas, where a “Green Schools” initiative is underway. FCT is simultaneously organizing a broad farmer network (for the entire Nudo del Azuay, including Dudas) called ‘Amigos del Sangay’, as a means for the local population to collectively voice their concerns and ideas to improve existing management of the southern edge of Sangay National Park.

## **Conclusion**

The Dudas watershed is strategically important both for its biological and hydrological resources as well as for its rich cultural history. FCT’s goal is to strengthen and expand conservation initiatives in this area by stabilizing the agricultural frontier and providing viable economic alternatives to deforestation. In 2009, FCT will launch a pilot program for the payment for the protection of environmental services (PPES) in the Dudas and neighboring Mazar watersheds.

In the coming months, FCT will be collaborating with outside experts to perform an in-depth socio-economic baseline study of the Dudas watershed. In addition, FCT will evaluate opportunity costs under the expert guidance of Sven Wunder of CIFOR. This initial data will provide the necessary inputs for the design of the pilot PPES in the Dudas watershed.

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<sup>6</sup> The “comuna” (the term used commonly by Dudas residents) petitioned legal status before the Ministerio de Comercio Exterior, Industrialización, Pesca y Competitividad (MICIP) in early 2004, but we are unaware if this process has been finalized. Also proposed has been “La Asociación Agroartesanal y de Turismo Comunitario ‘San Antonio de Dudas’”, promoted by EcoHomode. The Asociación is perhaps the same organization referred to as the ‘comuna’ by residents. EcoHomode no longer works in the Dudas, but we will be consulting further with them regarding these organizations.

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