LANDSCAPE MANAGEMENT IN CHOCÓ-DARIÉN

PRIORITY WATERSHEDS







MacArthur Foundation

Kingdom of the Netherlands

DFID Department for International Development

WWF

Landscape management in Chocó-Darién priority watersheds

ISBN Ebook: 978-958-8353-77-7

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Published in February 2014
by WWF-Colombia

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CONTENT

CHOCÓ-DARIÉN
ONE OF THE MOST BIODIVERSE REGIONS IN THE WORLD

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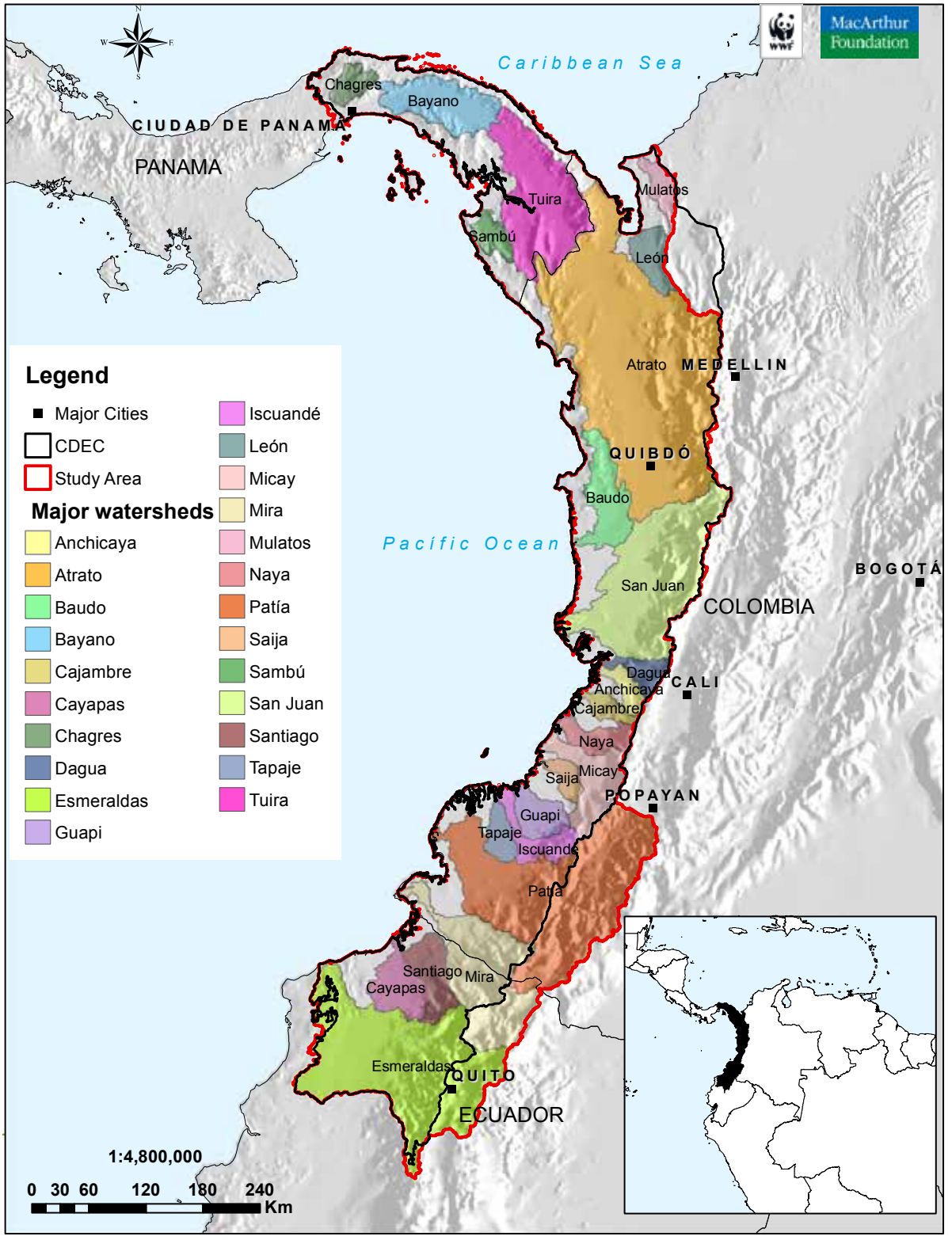
The Chocó-Darién ecoregional complex spans across approximately 17 million ha, from Eastern Panamá to Northwestern Ecuador. It is one of the most biodiverse regions in the world, recognized for its multitude of forest and freshwater ecosystems, including mangroves, estuarine forests, lowland and montane rain forests. These distinct features all contribute to its renowned biological singularity.

More than 7,500 species of plants (of which 1,300 are endemic), 700 butterflies and more than 1,500 birds are found in the Chocó-Darién Ecoregion. Due to its strategic location at the crossroads of the migration routes of numerous species, its coastal ecosystems harbor important populations of marine turtles, shorebirds and humpback whales (Map. 1).



Map 1. Major watersheds of the Chocó-Darién.

A REGION OF UNIQUE SOCIO-CULTURAL VALUE

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The Chocó-Darién is the homeland of nine indigenous groups, numerous Afro-descendent communities and a growing mestizo population. Sixty percent of the Colombian Chocó-Darién territory is owned by Afro-descendants communities and twenty percent by indigenous peoples. On the other hand, thirteen percent of the Colombian Chocó-Darién territory is under a strict protected area figure.

Several indigenous territories overlap with national parks (e.g. Darién National Park in Panamá, Utría, Paramillo and Katíos National Parks in Colombia). This pattern of land tenure favors conservation and sustainable development at a regional level, as community based political processes can be related to a collective long-term vision for the territory enhanced by the conservation objectives of the protected areas.

Table 1. Chocó-Darién Protected Areas and Indegenous Lands

Country	Figure	#	Area (ha)	% CDEC	% Pais
Panamá	Indigenous (Comarcas)		964053	5,7	12,7
	Protected Areas [1]		865531	5,1	11,4
Colombia	Afrocolombian (Community Councils)		5164807	30,5	4,5
	Indigenous (Resguardos)		2147071	12,7	1,9
	Protected Areas		1455478	8,6	1,3
Ecuador	Afroecuadorian		660993	3,9	2,6
	Indigenous (Reservas)		779638	4,6	3,0
	Protected Areas		850591	5,0	3,3

Refer to Appendix 1, pag. 65

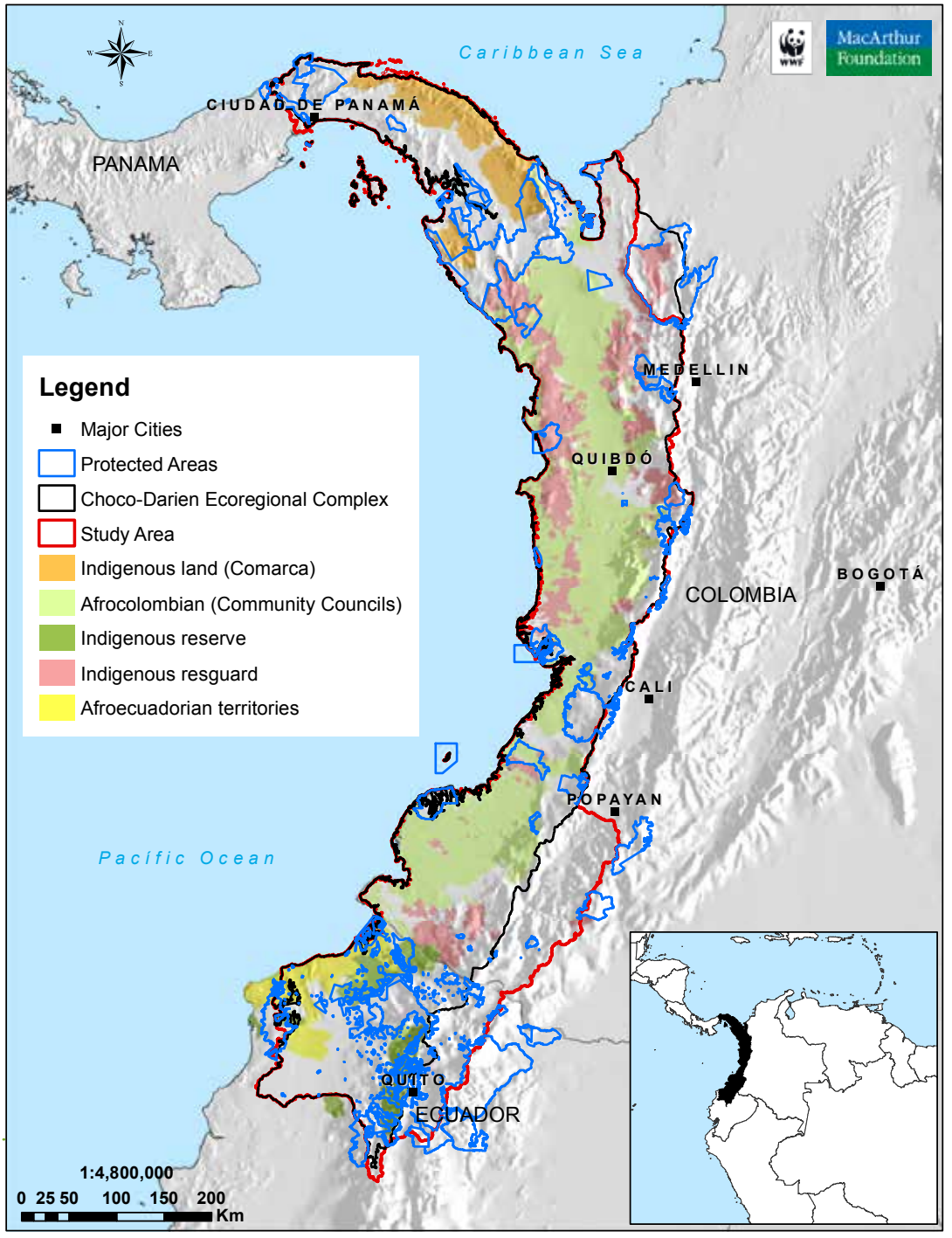
Due to recent key commercial stakeholders' (timber, gold and fisheries) interest in the promotion of fair trade initiatives and legal and sustainable resource management, there is now an important window of opportunity to work on sustainable development issues in the region.

Integrated and climate smart conservation approach in Chocó-Darién

It has been proven that landscape-scale approach for the conservation and sustainable management of biodiversity in the Chocó-Darién is useful for establishing the basis for the development of a strategic framework for such local and regional initiatives.

From 2001 through 2004, WWF Colombia joined efforts with partner organizations, CECOIN and Fundación Ecotrópico, to carry out an Ecoregional planning process. This included the establishment of a biodiversity georeferenced database and thematic maps such as types of vegetation coverage, ecological integrity and ecological functionality, all of which are very relevant to the selection of priority watersheds in the Ecoregional Complex. The results of this exercise provide a solid basis to address new challenges posed by climate change, as adaptation and/or mitigation actions have to be planned to ensure biodiversity conservation and the continued provision of ecosystem services into the future.

Considering this background, the MacArthur Foundation invited WWF to develop a proposal for the effective landscape management plans that aimed to maintain the ecological integrity and ecosystem services of high priority watersheds of the Chocó-Darién ecoregional complex. This proposal aims to con-



Map 2. Chocó-Darién Protected Areas and Indigenous Lands

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tribute to the development of the MacArthur Foundation's Conservation and Sustainable Development Strategic Framework, based on the experience gained by WWF and a wide network of partner NGOs, grassroots organizations and governmental agencies over the past decade.

Study area

The geographic scope for the analysis includes all the watersheds that drains into the Chocó-Darién Ecoregional Complex (CDEC). This area includes the Panamá Canal, the Darién Gap, the montane forests of the Pacific slope of the Northern Andes in Colombia and Ecuador, and the moist lowland forests of the Pacific. This delimitation was a result of the biogeographical analysis conducted by WWF, Ecotropico and Cecoin (2008), that amended the boundaries of the ecoregions that are part of ecoregion Complex, defined by Olson & Dinerstein (1998) in the Global Study of ecoregions, known as Global 200 Ecoregions.

The CDEC has an area of 16'933. 962 has. The boundaries established for the study area include the complete watersheds of Patía, Mira and Esmeraldas rivers it reaches a total of 18'753.010 has.

Map 3. Chocó-Darién Ecoregional Complex (CDEC) and Priority Watershed Study Area

Ecoregional Workshop. Cali, May 2012

Summary of Results

Assessment of pressures and threats to biodiversity and vulnerability to climate change

A large number of significant pressures are threatening biodiversity preservation and the value of services provided byecosystems present in the Chocó-Darién ecoregional complex. During the past eight years the number of mega infrastructure projects planned for the Chocó-Darién have increased significantly.

Increasing threats and drivers of biodiversity loss

Economic development in the region has been largely based on extractive practices that have resulted in the loss of ecological integrity in many areas. In addition to the inadequate, illegal or uncontrolled use of timber and non-timber forest resources that has taken place for centuries, illegal, uncontrolled artisanal and/or large scale mining, infrastructure development (roads, ports, energy generation and transmission) and the establishment/ expansion of forest plantations and agro industry plantations are contributing to the deterioration and impoverishment of natural ecosystems, which are reducing their resilience to the negative impacts of climate change. Due to the remoteness of the region, local communities are highly vulnerable to poverty, illiteracy and social inequity. This makes it urgent to develop comprehensive measures flexible enough to adapt to environmental change.

Addressing the threats and drivers of biodiversity loss in this ecoregion is important in order to mitigate the impacts of climate change and preserve the lives and traditions of indigenous and Afro-descendent communities. To do this, we need to improve our understanding of current drivers and threats of forest ecosystems' conservation: how these factors may influence different parts of

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Ecoregional Workshop. Panama City, August 2012

the region and relative vulnerability to climate change scenarios. Based on this knowledge, priority watersheds and needs can be identified for more effective investment and conservation action. This priorities identification will allow the design of effective landscape and river basin management plans in order to ensure ecosystem resilience and to build the adaptive capacity for local communities to cope with climate-related impacts.

Further, a more solid understanding of the drivers of change relative to conservation priorities is needed to direct investment in cross-cutting policy actions that support local level actions and create the broad based enabling conditions for biodiversity conservation and well-being of communities in the Chocó Darién ecoregion.

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Analysis of national development plans and infrastructure projects

Information related to sectorial policies and mega-projects for the whole ecoregion (Colombia, Panamá and Ecuador) was updated. The results of this study include the analysis of sectorial policies and plans, particularly of the current status of mining, oil, roads, railroads, seaports' expansion, power genera-

2. Consejo Nacional de Política Económica y Social (CONPES): maximum national planning authority who serves as an advisory body to the Government on all matters relating to economic and social development.

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Ecoregional Workshop. Cali, May 2012.

tion, oil pipelines and agriculture projects. It also included the analysis of policy papers as CONPES[2] (in the case of Colombia) and other relevant institutional documents, information exchanged with others NGOs and the private sector, and the identification of initiatives led by community based organizations on these issues.

The report lists both ongoing and projected developments, found in the development and sectorial plans for each country, and provides information on the scope of each project, the geographic area affected, the organizations leading the projects and the financial sources. This information was georeferenced and used as a layer for the GIS analyses related with threats and deforestation / fragmentation trends. The information is extremely useful for monitoring and following-up activities during the environmental licensing process of the projects. It also provides useful information for designing communication strategies and disseminating information regarding these projects at local, regional, national and international levels.

The analysis described above was supplemented by national workshops (convened in Cali, Panamá City and Quito), and, local workshops (Metetí in Panamá and Ríosucio, Quibdó and Buenaventura in Colombia). In Colombia these events were convened jointly with the Common Agenda and Chocó Interethnic Solidarity Forum (FISCH, after its Spanish name). In Panamá we worked in collaboration with the National Association for the Conservation of Nature - ANCON, and in Ecuador with the support of ALTROPICO Foundation.

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National Development Plans

Colombia: four main policy documents were reviewed and analyzed: "Vision Colombia II Centenario: 2019" prepared by the National Planning Department (2005), the National Development Plan 2006-2010, the "National Policy for Competitiveness and Productivity", and finally, the 2010-2014 National Development Plan (NDP).

Broadly speaking, all these policies intend economic growth through the promotion/expansion of the main productive sectors (known today as locomotives of development: mining, energy, petroleum, infrastructure, agroindustry, etc.). Additionally, all set specific goals related to transport/roads networks consolidation (internal and cross-border), energetic self-sufficiency, increasing of exports from extractive industries, electric energy, among others.

The Policy documents reviewed barely mentioned the environment in their goals, and none of them establish specific strategies to guarantee the effective inclusion of socio-environmental consideration in sectorial planning.

Ecoregional Workshop. Metetí, Province of Panamá. August 2012.

Ecuador: The Constitution of Ecuador, promulgated in 2008, established an institutional restructuration of the State through: territorial reorganization, decentralization of governance and the creation of new tools for planning and territorial management. Therefore, most of the current sectorial initiatives respond to the mandate of the Plan Nacional para el Buen Vivir 2009 - 2013, since there are no sectorial policies independently defined. In the Ecuadorian constitution, several articles are closely related to the development of a strategy for sustainable development in the Chocó-Darién, since they establish nature's rights, promote a healthy environment, ensure territorial sovereignty and peace, and promote strategic integration with the rest of Latin America and the world while strengthening national identity, plurality and multiculturalism.

Panamá: The target set by the government in its Strategic Plan 2010-2014 was to become the "Hub of the Americas". Panamá aims to increase volume and products that are transported across the Panamá channel and to become a hemispheric leader in value-added logistics services. The Panamánian government also seeks to build and improve roads to enable further development of agriculture connecting the Darién Province ince with agricultural sectors and interconnecting its energetic grid with Colombia to promote the development of a regional electricity market.

Colombia: The transport sector increasing interest in the region is illustrated by the increased number of projects planned, that raised from 10 in 2005 to 18 in 2012.

Ecuador: Nine of the thirteen mega-projects in the Ecuadorian National Development Plan relate to the development of the road network.

Panamá: For the Panamenian portion of the Chocó-Darién two mega-projects are associated with infrastructure: the Panamá Canal expansion and the electrical interconnection with Colombia.

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Poorly Planned Infrastructure

Colombia: According to Colombia's policy documents, important transport and infrastructure projects are planned to be developed in the Chocó-Darién region: the consolidation of the road network; the expansion of the installed capacity of the seaport system; the improvement of river transportation that includes the recovery of river navigability and the construction /improvement of infrastructure of national importance along water courses in the Pacific basin; the articulation of the existing railroad network; and the development of logistics and border crossings. The transport sector increasing interest in the region is illustrated by the increased number of projects planned, that raised from 10 in 2005 to 18 in 2012.

Ecuador: Nine of the thirteen mega-projects in the Ecuadorian National Development Plan relate to the development of the road network, mainly targeting the expansion and rehabilitation of existing ones, with emphasis on strengthening the east – west connections. The hydroelectric, oil (heavy crude pipeline project), port and rail sectors, also have at least one megaproject each.

Panamá: For the Panamenian portion of the Chocó-Darién two mega-projects are associated with infrastructure: the Panamá Canal expansion and the electrical interconnection with Colombia. Unlike Colombia, which includes in its National Development Plan the "Transversal de las Americas" road as an important interconnection project with Panamá, Panamá has not established this as a project of national interest.

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Table 3. Mega infrastructure projects planned for the Chocó-Darién in Colombia

Sector	2005	2012
Roads	Tapón del Darién	
		Transversal de las Américas (Phase 1)
	Pereira – Nuquí	Pereira - Las Ánimas
		Las Ánimas - Nuquí
		Medellín - Quibdó
		Las Ánimas - Quibdó
		Buenaventura - Loboguerrero
Rail Roads	Pereira - Buenaventura	
		Pacific Train
		Barrancabermeja - Cupica
Electricity Interconnection	Colombia - Panamá	Colombia - Panamá (ICP)
	Colombia - Ecuador	Colombia - Ecuador (ampliación)
		Middle San Juan, Middle Baudó, Bajo Baudó and Sipí
		Cauca and Nariño Pacific coast
Hydropower	Small hydropower central Guapi	
Oceanic Canal	Atrato - San Juan	
Ports	Buenaventura	Buenaventura Port main access dregded
		Industrial Port Aguadulce
	Bahía Málaga Portuary Project	
	Tribugá Port	
		Tribuga Portuary Project
		Dagua river delta maritime project
		Bahía Cupica
Oil/Hydrocarbon Pipeline		Transandean oil pipeline Ecuador-Colombia border

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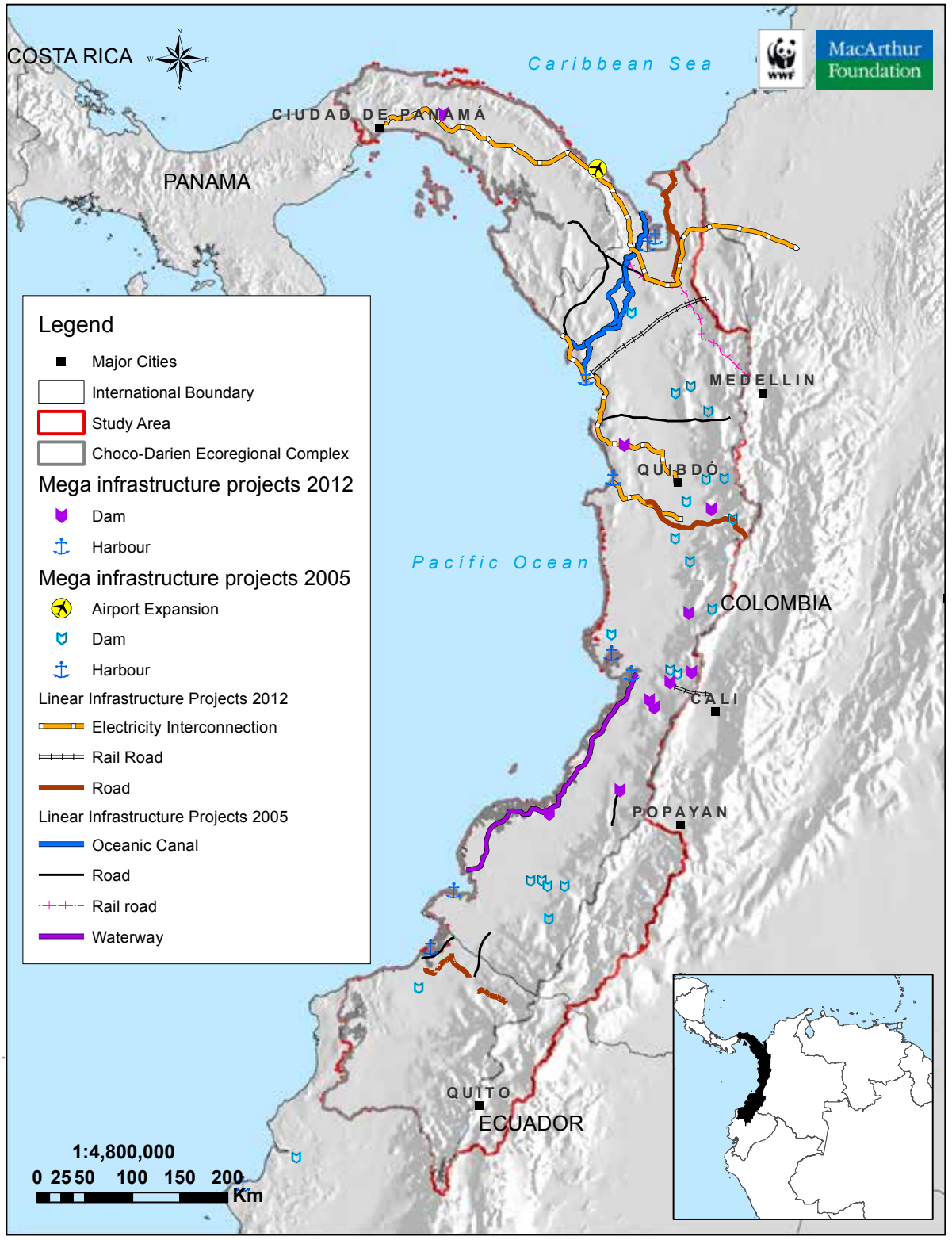
Table 4. Mega infrastructure projects planned for the Chocó-Darién in Ecuador

Sector	2012
Roads	Esmeraldas - Quinindé - Santo Domingo (E20)
	Road "Y" Tababuela - San Lorenzo - Esmeraldas - Pedernales
	Otavalo - Quinindé
	Otavalo - Ibarra
	Ibarra - Rumichaca
	Tulcán - Tufiño - Maldonado - Chical - Peñas Blancas (E182)
	Alternative road from Julio Andrade - El Carmelo road to the Panamerican highway
	Julio Andrade - El Carmelo - Puente Chingual
	Carretera Las Peñas - La Tola
Railroads	Ibarra - Salinas
Electricity Interconnection	Colombia - Ecuador (extension)
Ports	Artesanal Fisheries Port of Esmeraldas
Oil/Hydrocarbon Pipeline	Heavy oils pipeline (OCP)

Table 5. Mega infrastructure projects planned for the Chocó-Darién in Panamá

Sector	2012
Electricity Interconnection	Colombia - Panamá (ICP)



Map 4. Mega infrastructure projects planned for the Chocó-Darién ecoregional Complex

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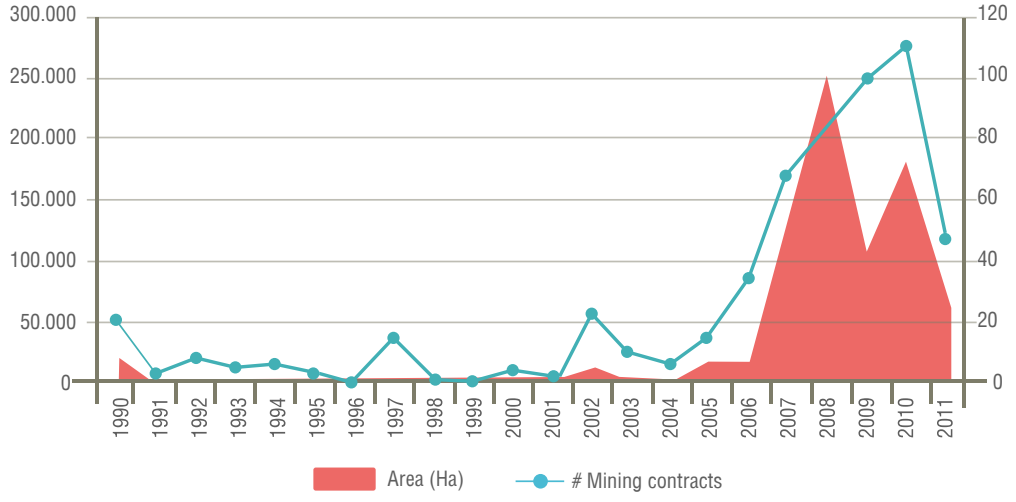
Graphic 1. Mining contracts dynamic for Chocó-Darién ecoregion in Colombia



Extractive activities

Colombia: In the Pacific region, between 1990 and 2011, a total of 564 mining contracts were granted. Seventy percent of the titles correspond to metallic minerals (gold, silver, copper, platinum, molybdenum, manganese, lead and zinc, among others), and 30% to non-metallic minerals (building materials, sand and gravel, among others). Most of these contracts were granted in the departments of Antioquia (178), Chocó (133), Nariño (80) and Valle (77). These titles cover approximately 830,000 hectares.

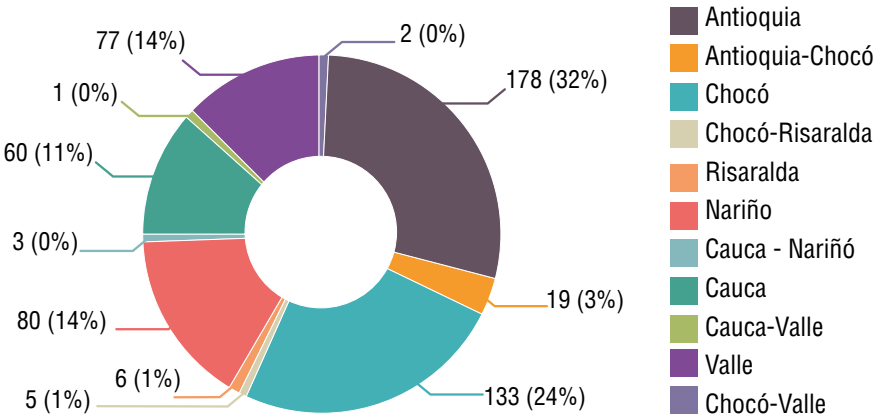
Mining: For the past five years the mining industry has been growing both in mining projects and the total area affected by mining.

Colombia: In the Pacific region, between 1990 and 2011, a total of 564 mining contracts were granted.

Ecuador: in Ecuador's Chocó-Darién, there were 1,092 mining contracts during 1992-2011, of which 140 are active.

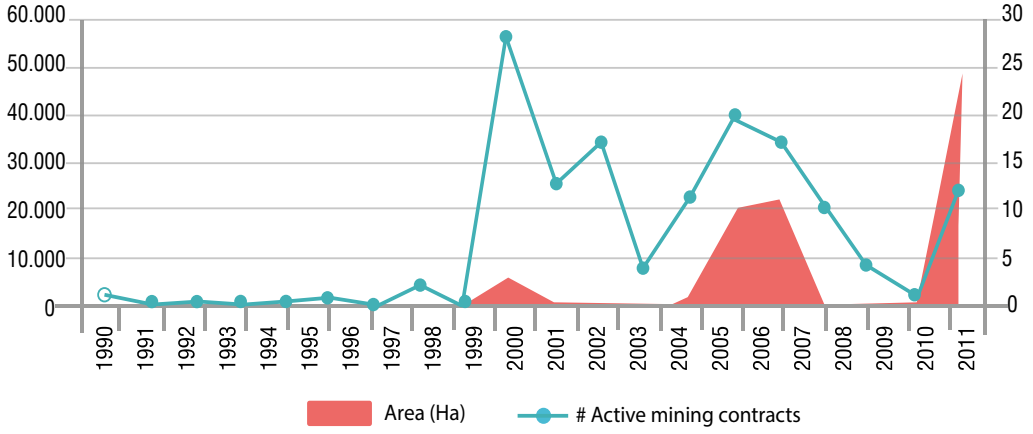
Panamá: there are 42 mining contracts in Panamá's portion of the Chocó-Darién.

Graphic 2. Number of mining contracts by department (1991 – 2011)



Ecuador: in Ecuador's Chocó-Darién, there were 1,092 mining contracts during 1992-2011, of which 140 are active. The largest number of active files correspond to the province of Imbabura (69 equivalent to 49%), followed by Esmeraldas (49 cases or 35%) and Carchi (22 cases or 16%).

Graphic 3. Mining contracts for Chocó-Darién ecoregion in Ecuador (1992 - 2011)

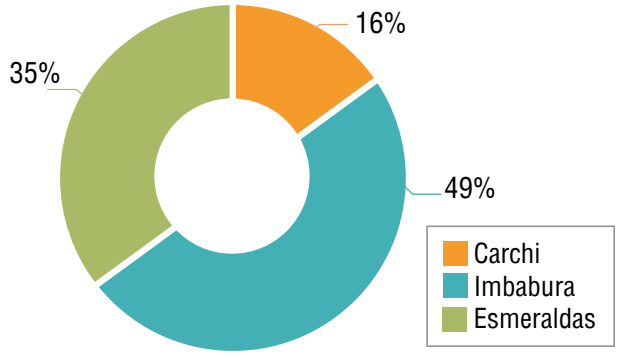


Río Dagua, mina de Zaragoza

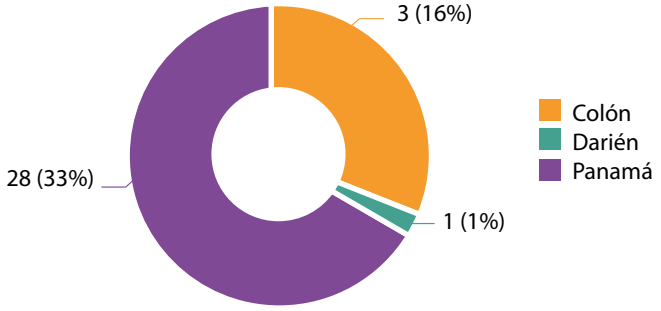
These contracts affect approximately 101,400 hectares (54% Esmeraldas, Imbabura 31% and 15% Carchi). The potential areas of exploration in Ecuador's Chocó-Darién in Ecuador are: Esmeraldas Province where there are reserves of alluvial gold in the Santiago, Cachaví, Huimbí and Carolina rivers, and in Imbabura Province where copper reserves have been identified in the Llumirahua.

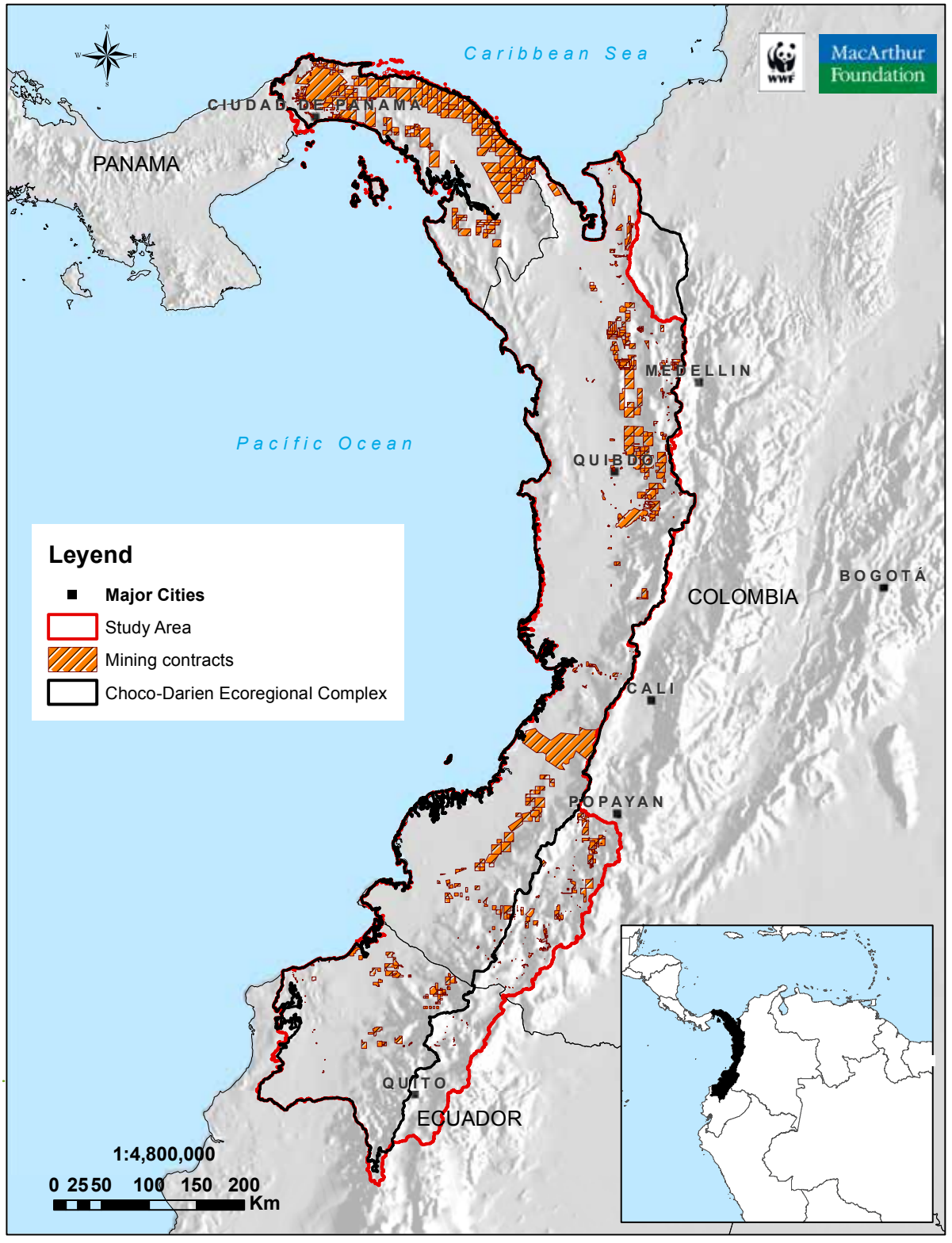
Panamá: there are 42 mining contracts in Panamá's portion of the Chocó-Darién: 39 are for nonmetallic minerals and three for metallic mineral exploration. The total area of such contracts cover around 30,310 hectares.

Graphic 4. Active mining contracts by Province in Ecuador (1991 - 2011)



Graphic 5. Mining contracts by Province in Panamá





Map 5. Mining contracts for the Chocó-Darién ecoregional complex

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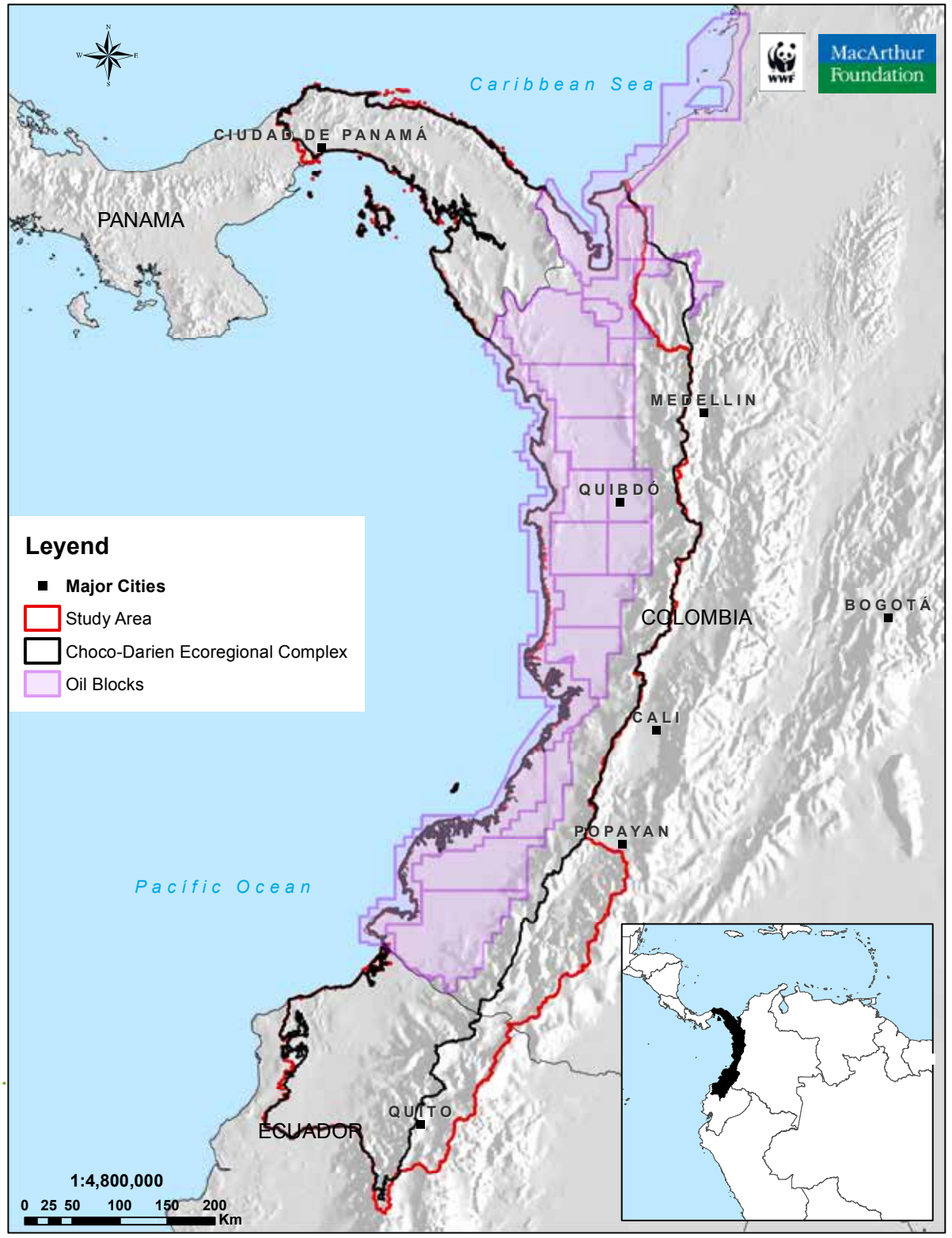
- Although mega - projects in the Chocó-Darién ecoregion largely correspond to development priorities established by national governments, most of the infrastructure projects that have been prioritized by the Colombian government do not have a defined budget. Therefore, most of the projects are still in a rudimentary stage and in many cases preliminary studies have not started.
- Governmental sectors are promoting separate agendas, have weak control, and suffer institutional and inter-sectoral disarticulation. Plans and policies are not well known locally and there is lack of coordination.
- The analysis and reflection among governmental agencies, communities, and NGOs, is an opportunity to build inclusive proposals and define policies that meet national goals and take into account the particularities, priorities and initiatives of different parties.

Oil/Hydrocarbons

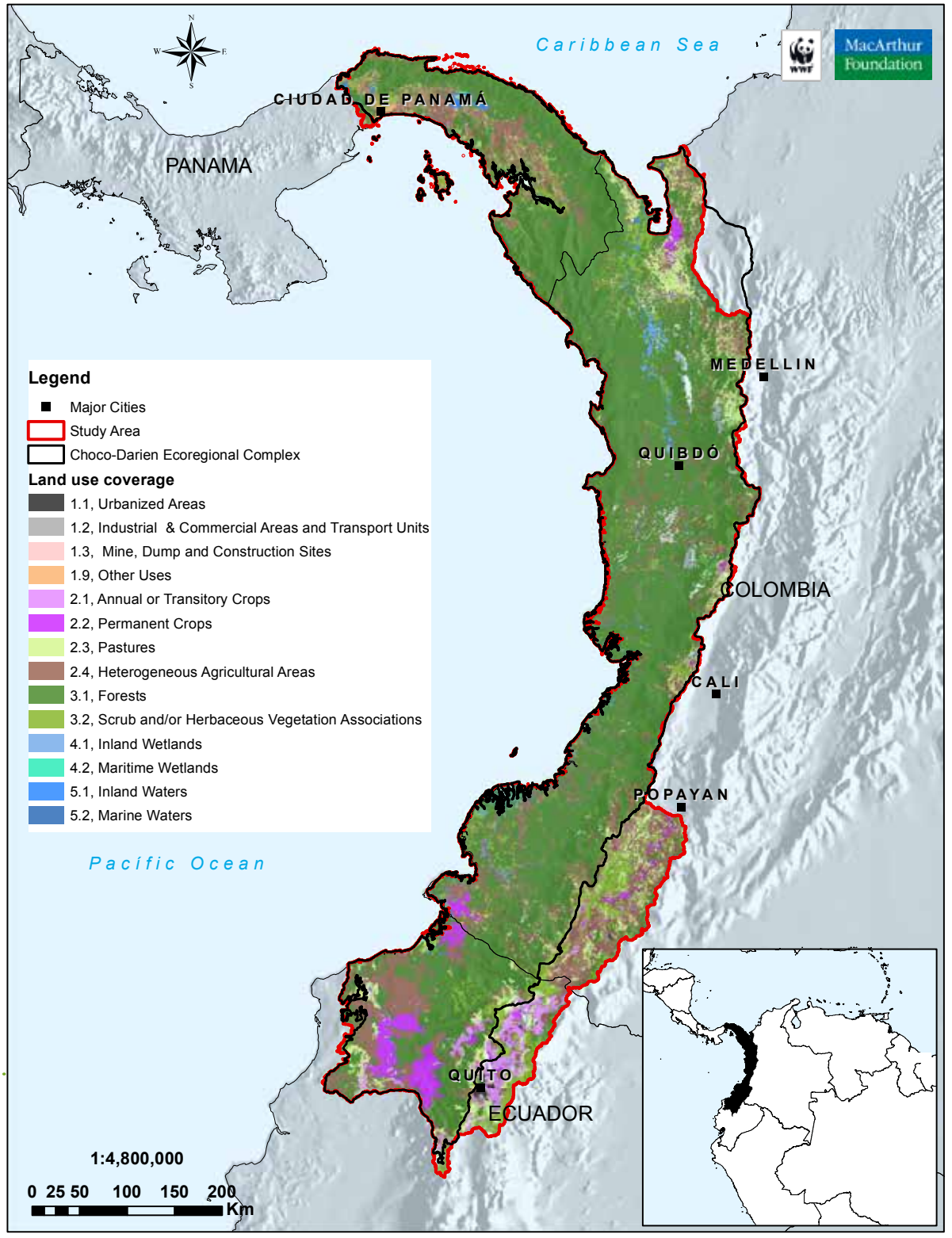
Colombia: there are 20 oil blocks in Colombia'ss Chocó-Darién (17 are in reserved areas), two Technical Assessments and one an exploration. These blocks reach an area of approximately 12,200,000 hectares and are located mainly in the departments of Chocó, Cauca and Antioquia.

Panamá: no oil blocks are yet defined for the Chocó-Darién, although explorations are advancing in the area of Garachiné-Sambú Darién, on the Pacific coast in an area of approximately 7,400 km^2, and in Bayano-Chucunaque. The exploration and exploitation activities are being conducted primarily in the marine territory located in the Bay of Panamá, the Gulf of Panamá, the Gulf of San Miguel and part of Garachiné and offshore area of the Province of Colon and Kuna Yala.

Ecuador: There are no current or planned blocks for oil exploration and exploitation in the Chocó - Darién.



Map 6. Oil/ Hydrocarbons areas for Chocó-Darién ecoregional complex



Map 7. Land use coverage for the Chocó-Darién Ecoregional Complex.

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Land Use Coverage

An agreement with research institutes and Governmental Institutions allow to establish a technical and scientific cooperation that aims to update the cartographic information sources for the Chocó-Darién prioritization exercise. The methodological approach used for the coverage and land use map corresponds to CORINE LAND COVER (levels 4 and 5).

Code	land coverage	Area (ha)	%
1,1	Urbanized Areas	43.606	0,23
1,2	Industrial & Commercial Areas - Communication Networks	836	0,00
1,3	Mine, Dump and Construction Sites	2.461	0,01
1,9	Other Uses	38.167	0,20
2,1	Annual or Transitory Crops	327.637	1,76
2,2	Permanent Crops	483.949	2,60
2,3	Pastures	1.144.814	6,15
2,4	Heterogeneous Agricultural Areas	3.419.894	18,36
3,1	Forest	10.886.241	58,45
3,2	Scrub and/or Herbaceous Vegetation Associations	1.619.120	8,69
4,1	Inland Wetlands	78.223	0,42
4,2	Costal Wetlands	11.555	0,06
99	No data	567.445	3,05
	Total	**18.623.948**	**100,00**

Deforestation trends

A map of deforestation trends and scenarios was elaborated based on the statistics of deforestation available for the period 1990-2000-2010 from the IDEAM, WWF. These scenarios and the coverage map were used for the analysis of species distribution models, to improve climate change sensitivity analysis, to carry out analysis of representation, and spatial analysis of socio-economic variables to assess local sensitivity and capacity to develop adaptive responses to climate change.

The most important pressure fronts are in the department of Chocó in the municipalities of Lloró, Quibdó, and Bagadó, in the upper Atrato river; Tadó, Itsmina, Condoto and Nóvita (Chocó), Mistrató and Pueblo Rico (Risaralda) in the San Juan Basin, and in Antioquia the areas close to the road Medellin-Apartadó-Turbo. In Panamá, the main deforestation fronts are along the road from Panamá to the Pinogana district in the lower area of the Bayano and Chucunaque basins. In the south of the ecoregion the areas adjacent to the Tumaco - Pasto highway in Nariño are losing forest cover due to the expansion of the agricultural frontier, a process that is also taking place along the in the Mira and Esmeraldas river basins and the Andean region of Ecuador in the provinces of Imbabura, Pichincha and Carchi.

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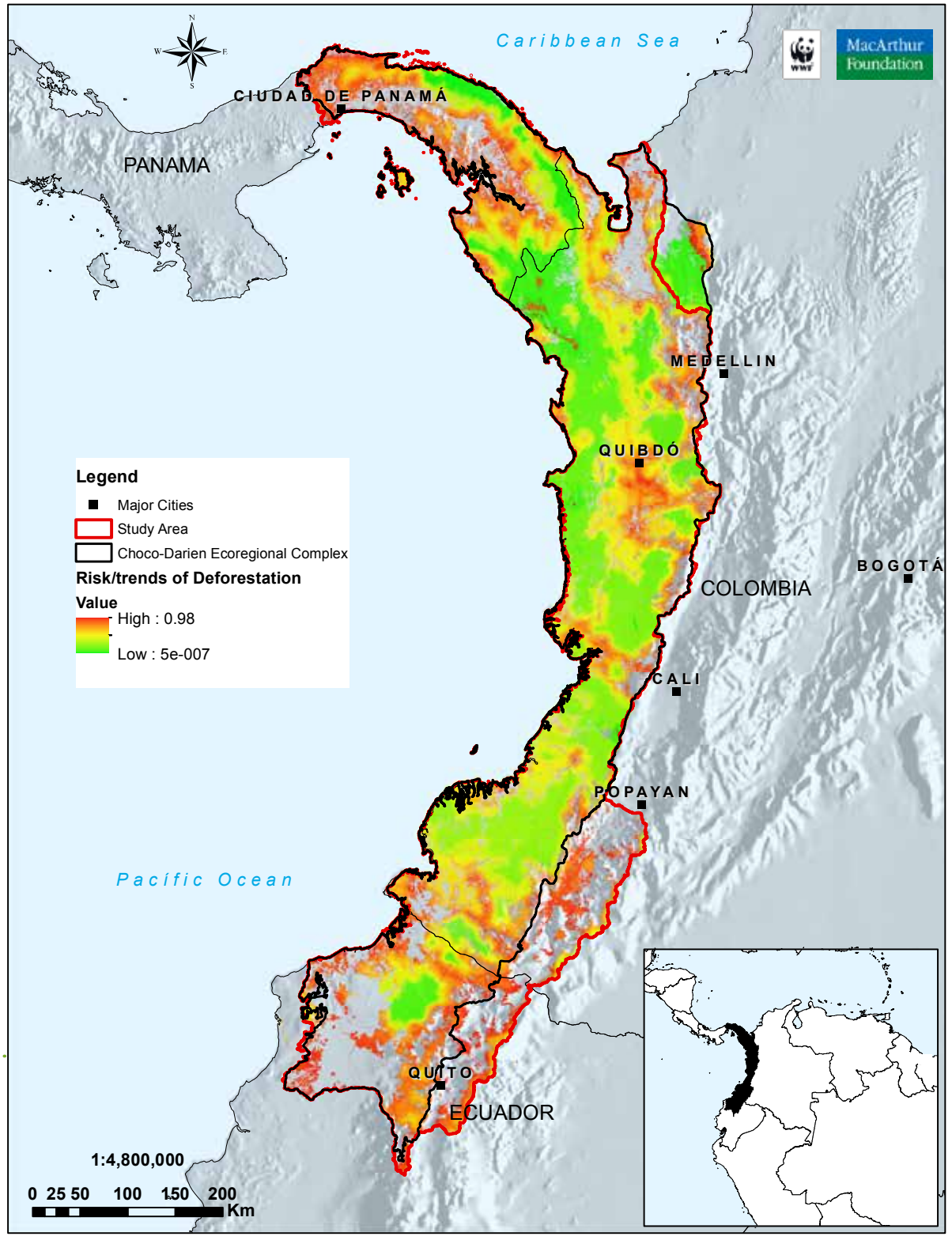
The results of the analysis of deforestation trends show that 66% of the Chocó-Darién is still covered by natural vegetation . However, the expected losses due to anthropogenic transformation for the next 40 years (2050), reach 1,516,759 hectares. This corresponds to 9% of the ecoregion, with an average annual deforestation rate of 37,919 ha/year. Main roads, electric interconnection, and mining and oil exploration are the largest drivers of the expected changes.



Map 8. Risk/ trends of Deforestation for the Chocó-Darién ecoregional complex.

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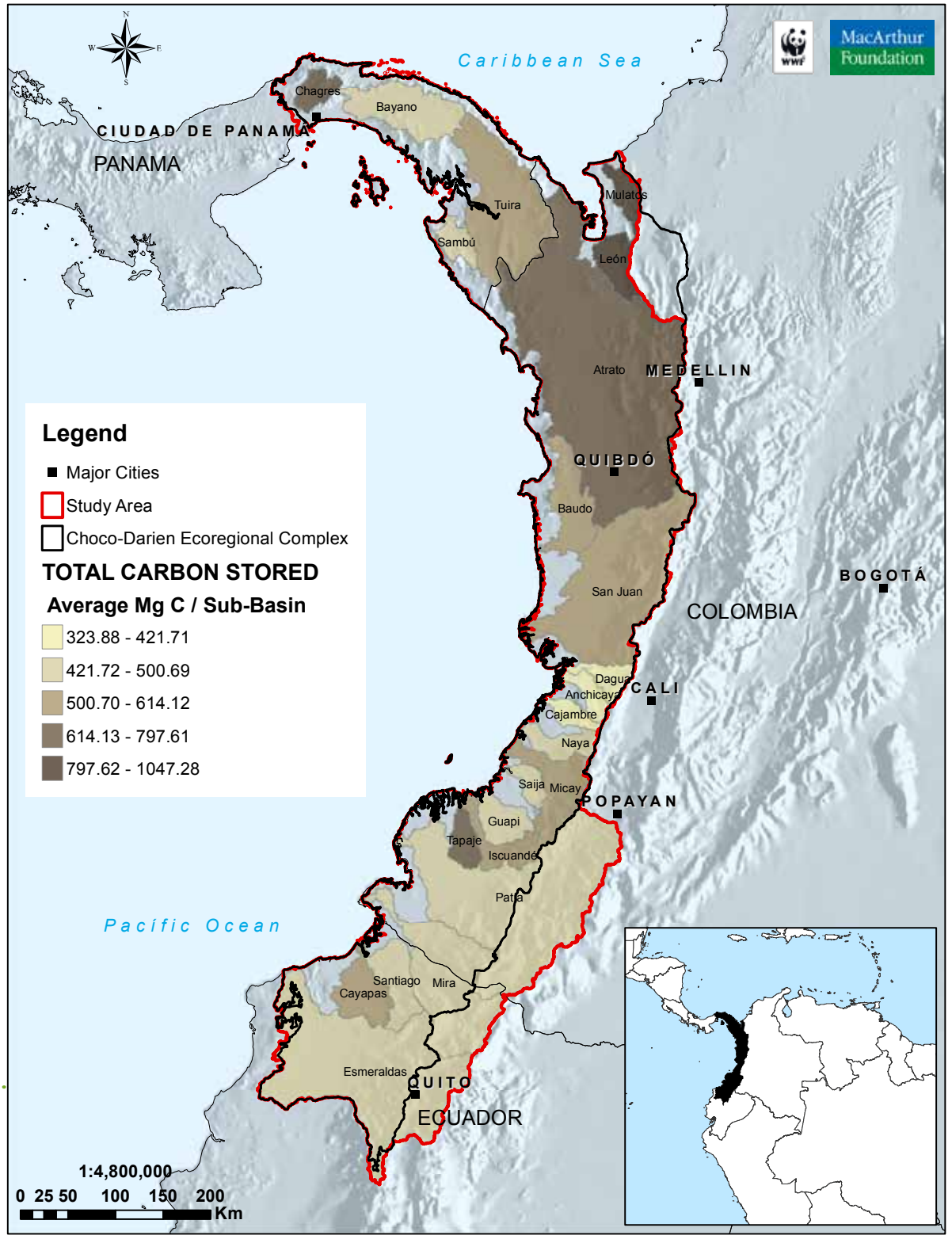
Chocó-Darién Watersheds Biodiversity and Ecosystem Services

More effective actions can be implemented to protect particularly vulnerable habitats, ecosystems and areas that may serve as a regugee for biodiversity in the Chocó-Darién by identifying priority watersheds due to their significant biodiversity and their ecosystem integrity (state conditions) and by modeling vulnerability of ecosystems and species to different climate scenarios. These actions also contribute to the maintenance of the overall resiliency of its ecosystems and unique ecological attributes.

Additionally, understanding the drivers of biodiversity loss and change is the first step forward to defining actions to reduce and mitigate threats that will potentially compound the impacts of climate change.

The Millennium Ecosystem Assessment (MEA. 2005), defines "ecosystem services" as the benefits that human populations obtain from ecosystems. Changes



Map 9. Carbon Stored for the Chocó-Darién ecoregional complex.

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in land use, landscape alteration processes and climate change, among other causes, have threatened ecological communities (Rozzi *et al.* 2001) and ecosystem services (Almeida-Leñero 2007). As part of the watershed prioritization exercise, we assessed some ecosystem services and model their tendency to change for the next 50 years. This can be used as criteria for prioritization and zoning according to the level of supply of each ecosystem service. Our analyses included stored carbon, sediment retention, water production and species diversity.

Carbon Stored: The above ground, below ground and dead biomass, were calculated according to secondary information and the land cover map. While the carbon content in soil was calculated taking into account soils maps available to the ecoregion. With these data the total carbon stored was calculated using the application InVest ver 2.1 (Tallis *et al.* 2011). With this base line, differences between the current and future storages were identified using the deforestation risk map produced to 2050.

The average carbon stored for the Chocó-Darién is 481ton/ha (σ = 250). TXWhe most significant changes detected were for the carbon stored in the soil. Mangrove forests had an average content of 1000 tonC/ ha (σ = 689). This illustrates their importance for organic carbon accumulation under the influence of periodic or permanent flooding both in the fluvial and marine floodplains, reaching approx. 500 - 1000 tonC/ha. In the district of Panamá lower montane rain forest reached the highest levels of carbon stored (520 tonC/ha). The Paramos (North Andean) store about 450 tonC/ha. The lower concentrations reported are in the forest and / or scrub dry mountain forests of Dagua with approximately 185 tonC/ha. Basins that have values greater than 500 tonC/ha are the Atrato, Serpe - Morro - Bongo - Buenaventura, Cajambre - Mayorquín - Dagua, Naya - Yurumanguí Iscuandé, Amarales - La Tola, Tapaje, Patía - Patía Viejo - Satinga - Sanquianga, Mira - Mataje and Mandinga - Amilia.

Retention of sediments: soil degradation is a process that reduces the current and potential capacity of soil to produce (quantitatively or qualitatively) goods and services (FAO and UNEP 1980). A practical way to quantify soil degradation is the Universal Soil Loss Equation (USLE, Wischmeier and Smith 1978). For its calculation we determined the rainfall erosivity (R), soil erodability (K), length and degree of slope (Ls), factor C, defined as the prevention of soil erosion due to land cover and use, and factor P, which estimates how management practices and land conservation practices fail to consider the erosion process. With these inputs we assessed the total sediment retention for each basin in ton/ha/year.

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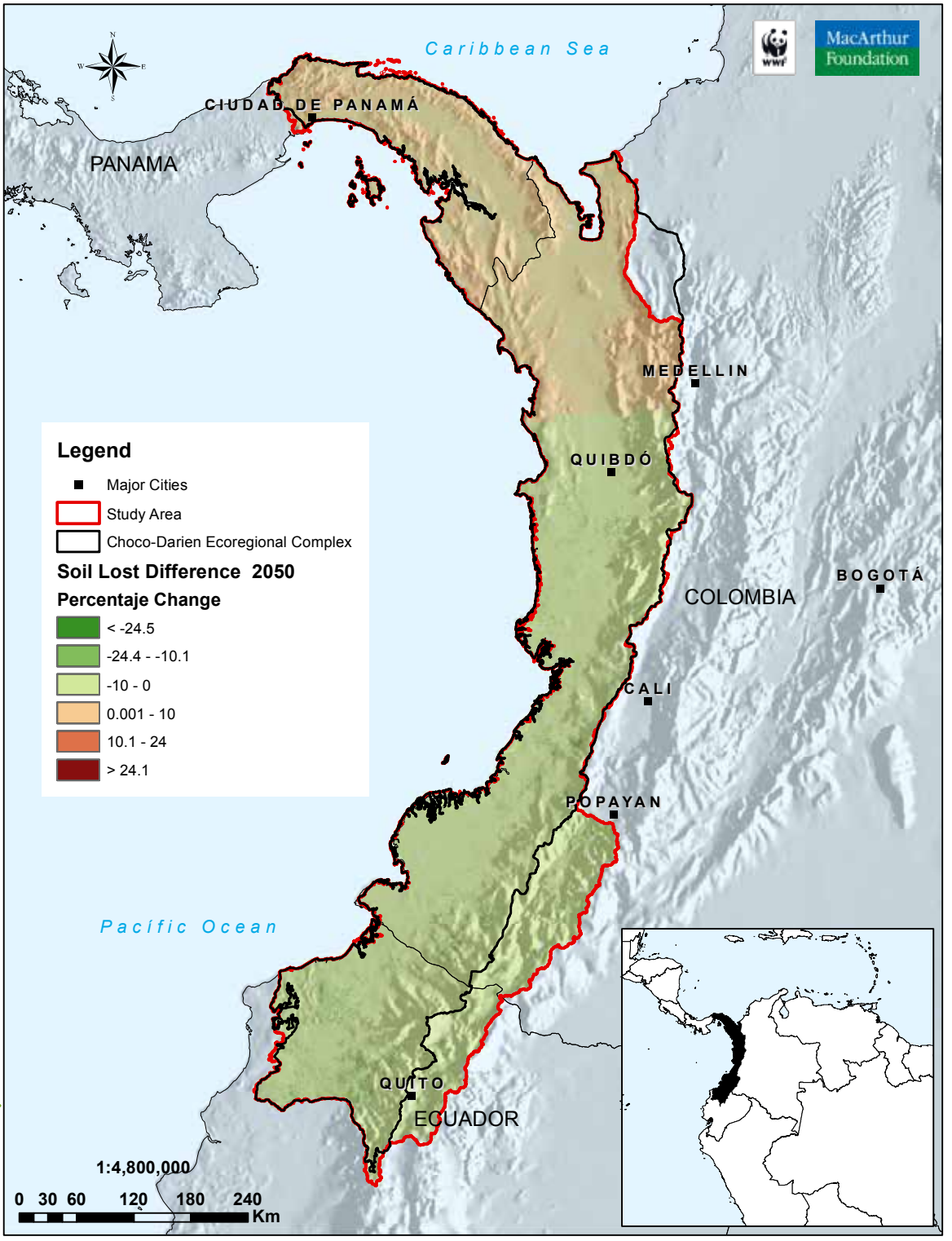
Results show a gradual decrease of erosion associated with the reduction of rainfall, particularly from the middle basins of Atrato and San Juan (Colombia's north and middle Pacific), and their headwaters, and from the Lower Atrato basin and the Gulf of Uraba (Colombia). Erosion values decrease for the Tuira and Bayano basins in Panamá, and increase for Chagres, Mandinga and Pácora basins in the foothills of eastern Panamá. In the southern portion of the Chocó- Darién, it shows high values in the headwaters of the Esmeraldas basin in Ecuador and for the Andean region, most of the Mira and Patia basins present erosion values greater than 20 tons/ha/year, related with scant vegetation cover and poorly developed soils and steep slopes.

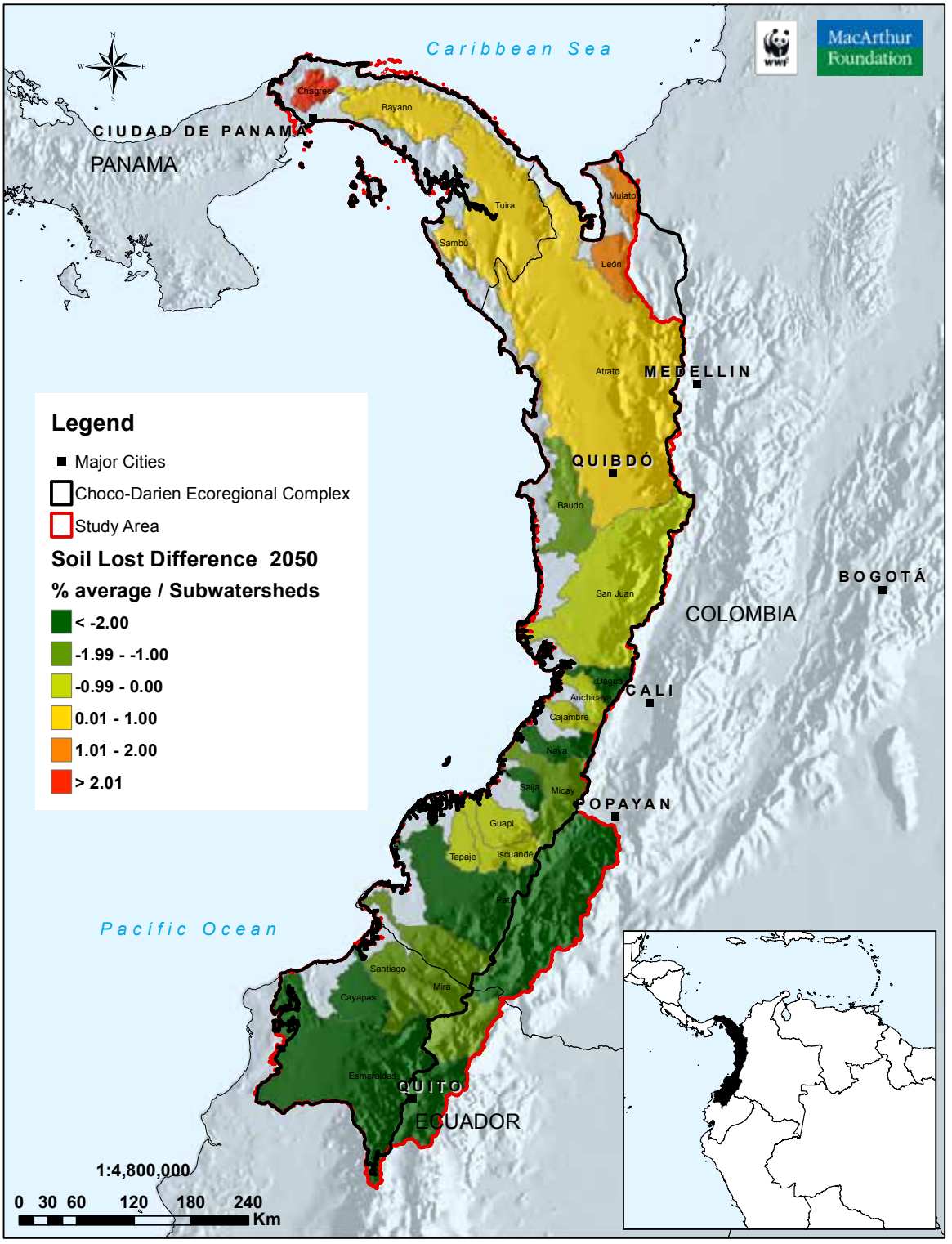
Water Provision: Biophysical characteristics of a watershed determine its capacity to respond to a specific rainfall event, as well as its environmental performance. For each basin we calculated the total water production, defined in m^3/ha, using the model proposed by Tallis *et al.* (2011 for Invest v. 2.1) including as variables precipitation, soil depth, and water availability in the soil.

a Pixels 100x100 m

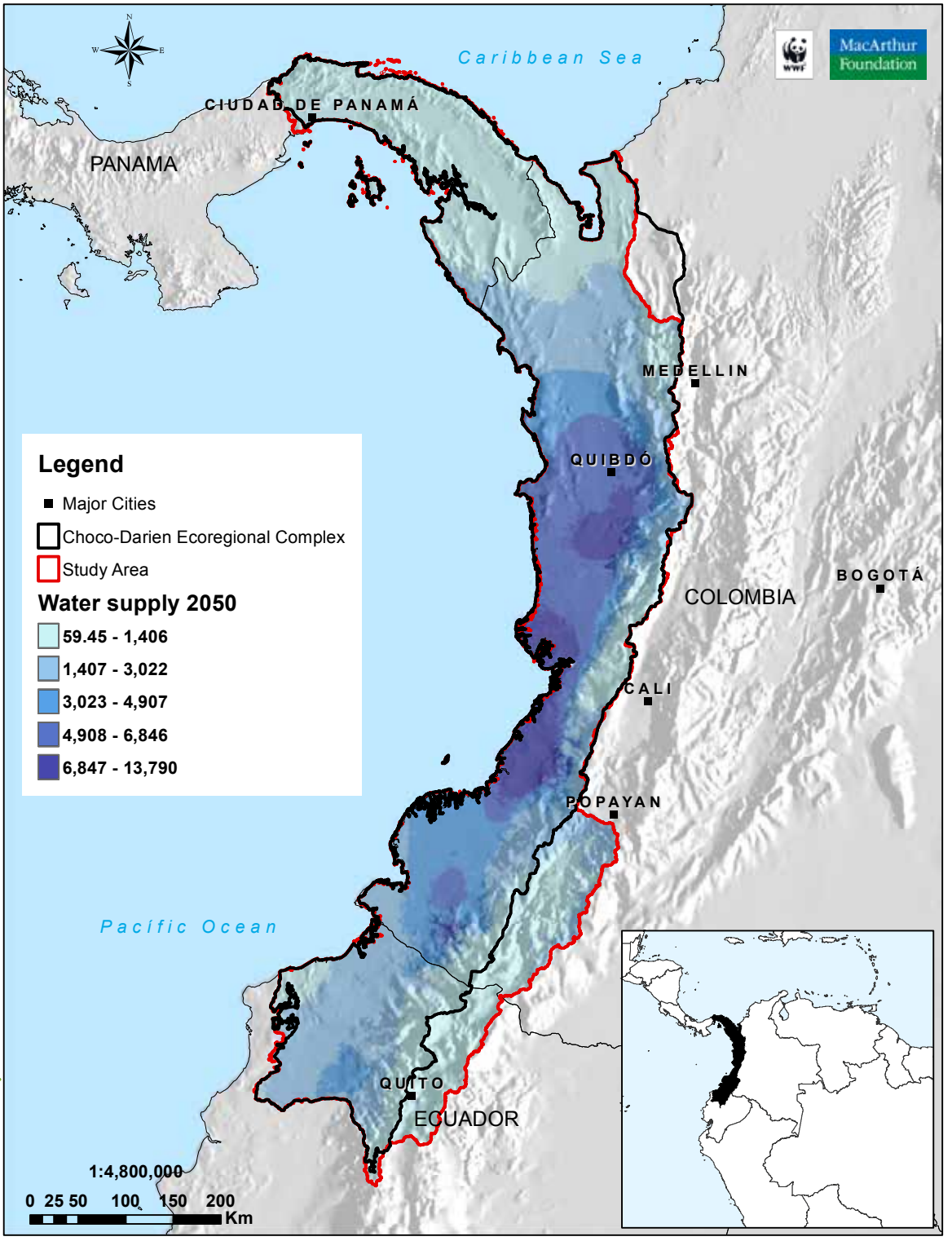


Map 10.
Changes in soil lost by pixel and subwatersheds (projected 2050)

b CDEC subwatersheds

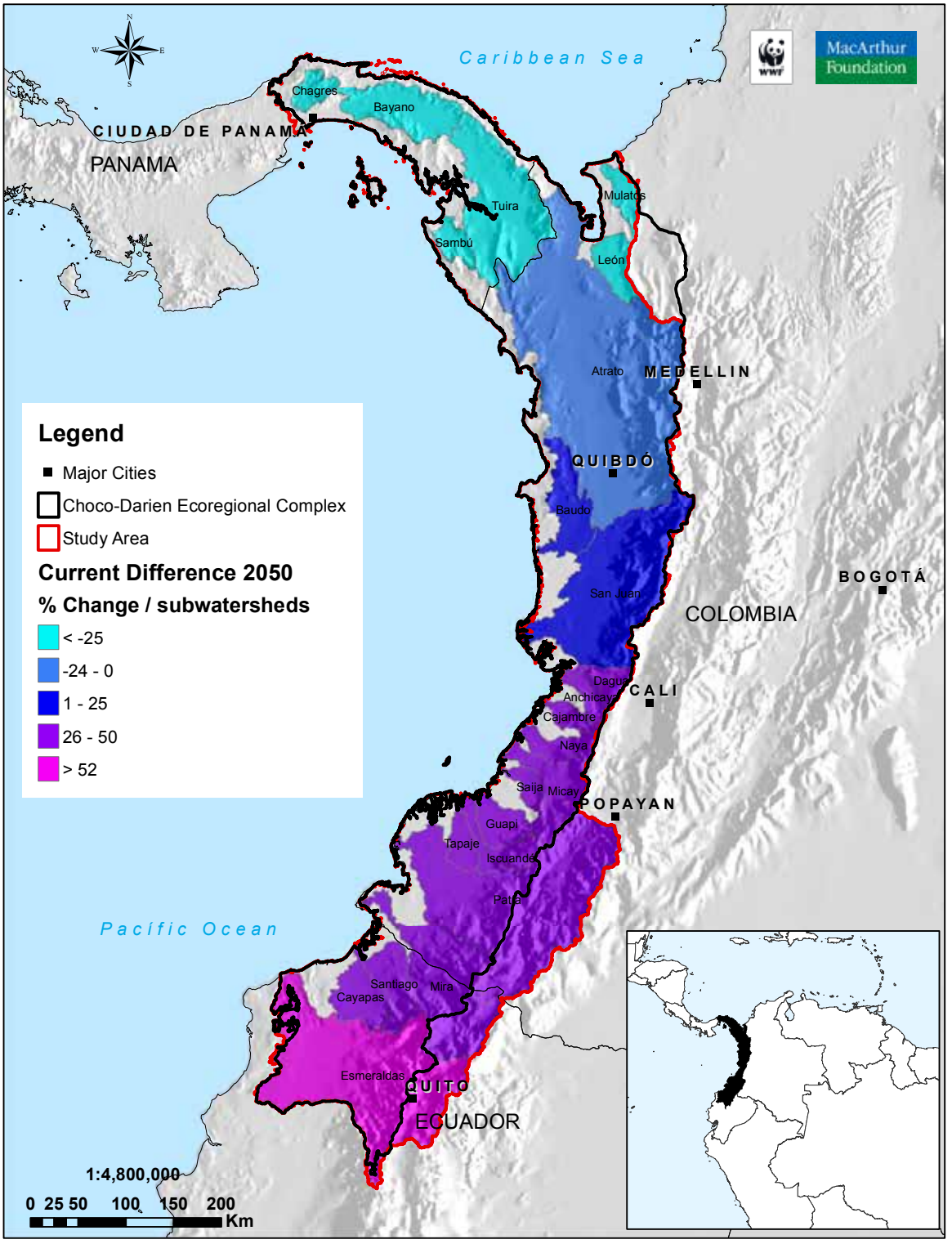


a Pixels 100x100 m



Map 11.
Changes in water provision by pixel and subwathersehds (projected 2050)

b CDEC subwatersheds



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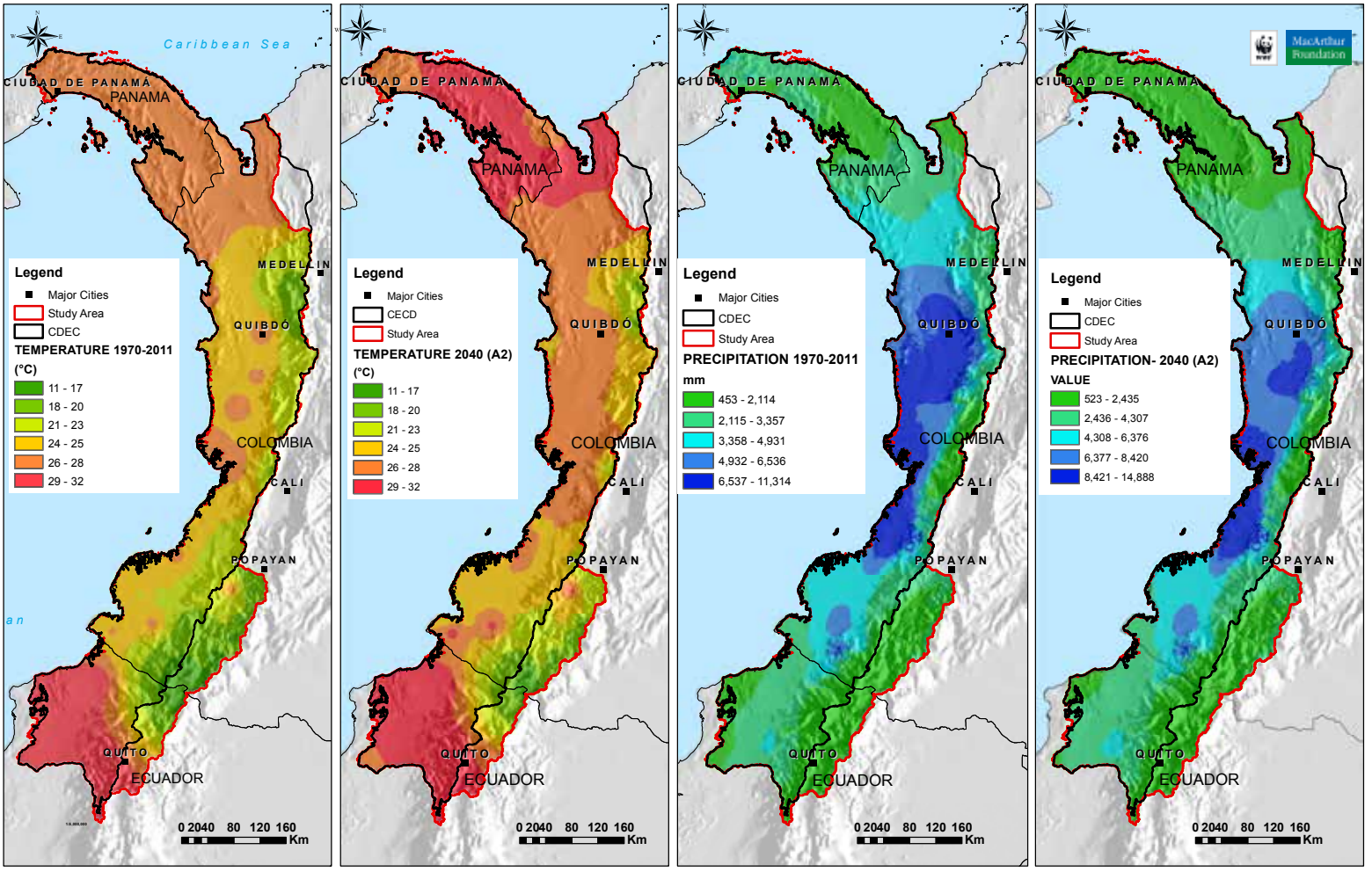
Results shows that the average usable sheet is 11% (v/v), with high values in the floodplain soils and piedmont ridge systems (<30%), and is lowest in the sandy soils of the coast (> 2.6% v/v. annual average rainfall of 5,011 mm, with maximum values of 11,314 mm and minimum of 453 mm. The average water production is 2,325 mm/year, with maximum values of 10,584 mm/year and a minimum of 40 mm/year.

Climate Change

Significant progress was made in the standardization of information for Chocó-Darién using data from meteorological stations for the last 30 years (domestic official sources from Panamá, Colombia and Ecuador). All information was systematized in Excel and used to model historical climate profiles (precipitation, maximum temperature, minimum temperature, mean temperature, climate variability and extreme weather events).



Map 12. Chocó-Darién Cilmate Changes scenarios

The information was integrated into a Geodatabase (ArcGIS) and climate change scenarios (A2 and B2) (raster) for (2040-2070, 2070-2100) analyzed.

Species distributions niches and climate change sensitivity

A species turnover rate was estimated based on the distribution of current and future climatic niches. The results indicate that mammals will be the group with more significant changes in its distribution patterns. The Andean foothills in the departments of Nariño, Cauca, Valle, Risaralda and Chocó are the areas which show the greatest expected change, as well as the southern portion of the mountains of Baudó on the western side of the Atrato river basin. The mountains of Los Saltos, are also an area with significant expected changes. Border areas with Ecuador and Panamá, include places where changes are expected at the same level as those already described but more restricted geographically.

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In the case of amphibians, the changes in distributions patterns will be more dramatic in the Andean foothills of the departments of Valle del Cauca and Chocó. However, the magnitude (number of changes), is evident in both Colombian and Ecuadorian coastal areas. The mountains of Panamá show predictable changes.

Birds show a pattern very similar to that described for amphibians. The largest expected change in bird distribution also lies in the foothills of the Andes but significantly extends along the western slope of the mountains of Baudó, and the coastal border between Colombia and Ecuador. The border region with Panamá presents a parallel pattern on both coasts, along the foothills of the mountains and the Pirre - Tacarcuna mountains.

The plants provided a different but complementary panorama in relation to other groups that were analyzed. Changes are expected to occur in the coastal areas, while no substantial changes are expected to occur in the middle and lower areas of the Atrato, the Baudó mountains, Los Saltos, Darién and the Andean foothills.

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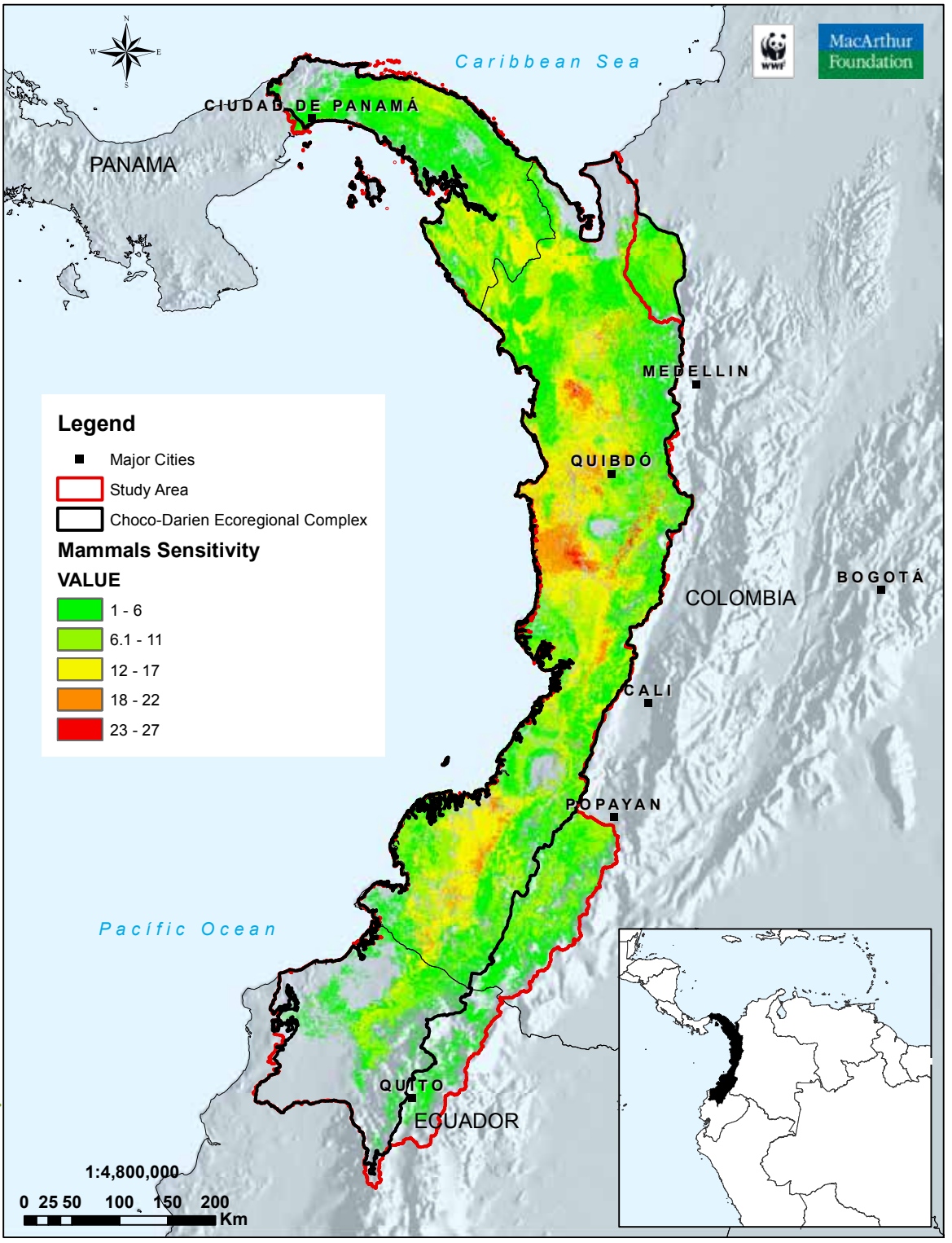
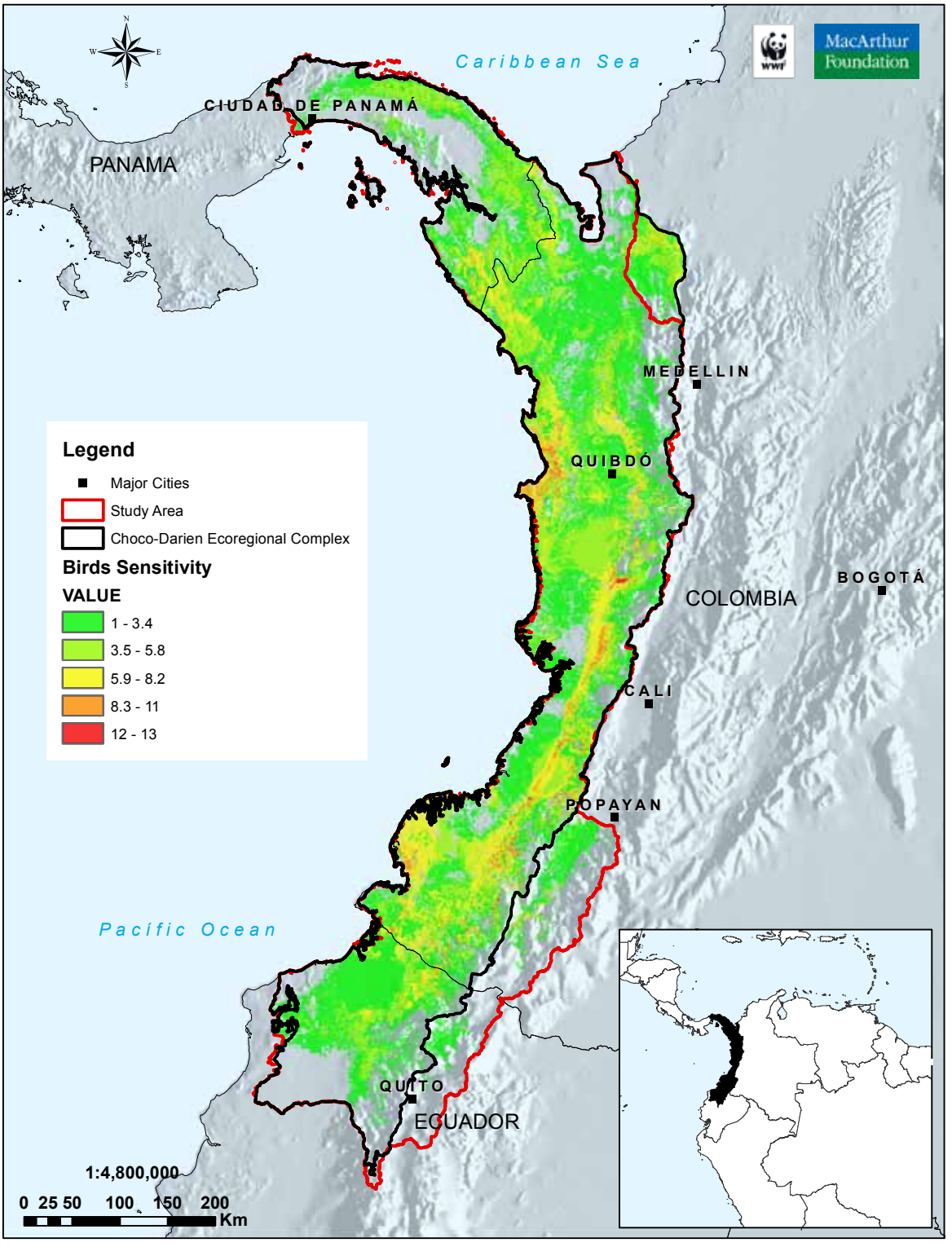
a Amphibians climate change sensitivity 2050 (A2 scenario)

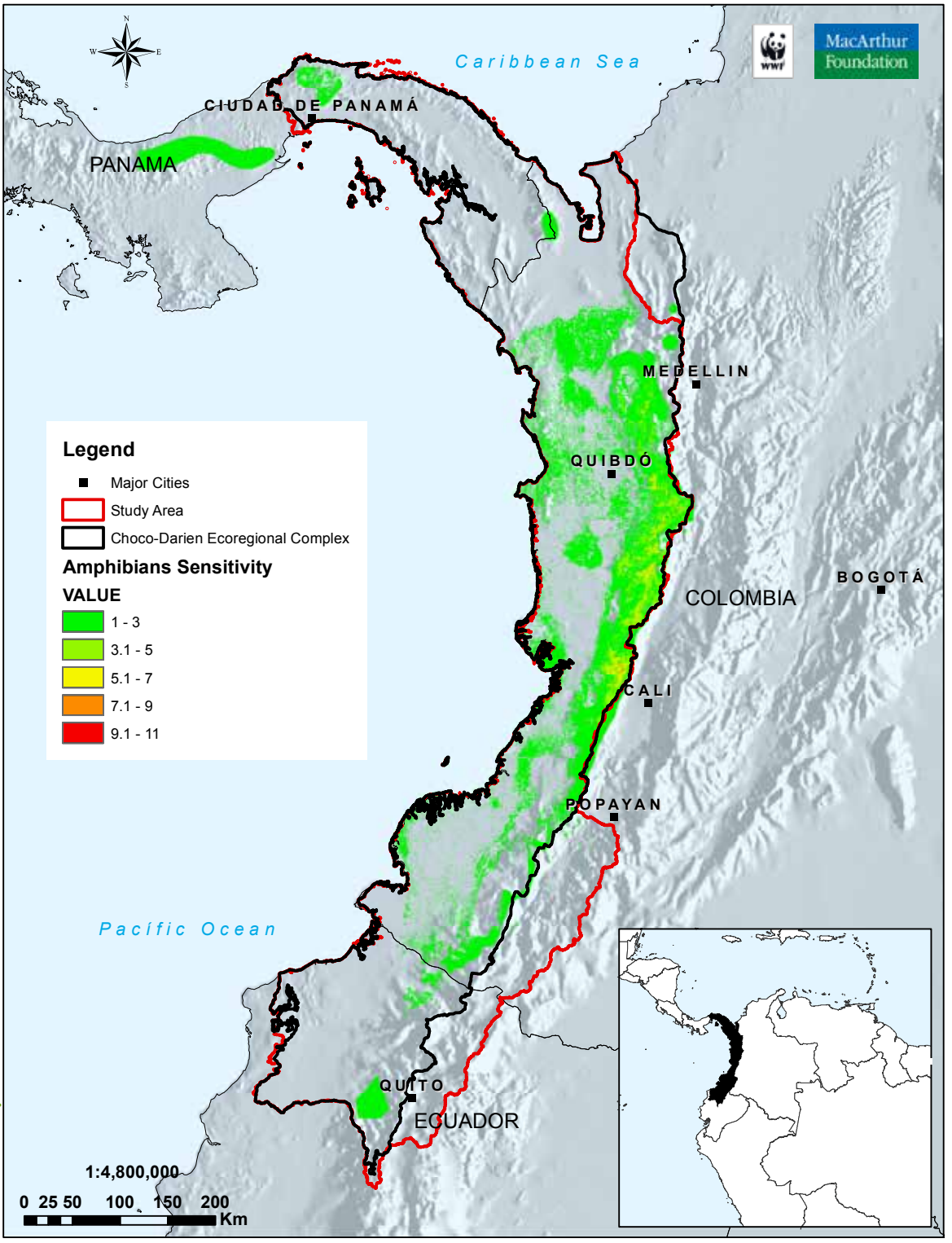


Map 13.
Climate Change sensitivity by taxonomic groups

b Birds climate change sensitivity 2050 (A2 scenario)

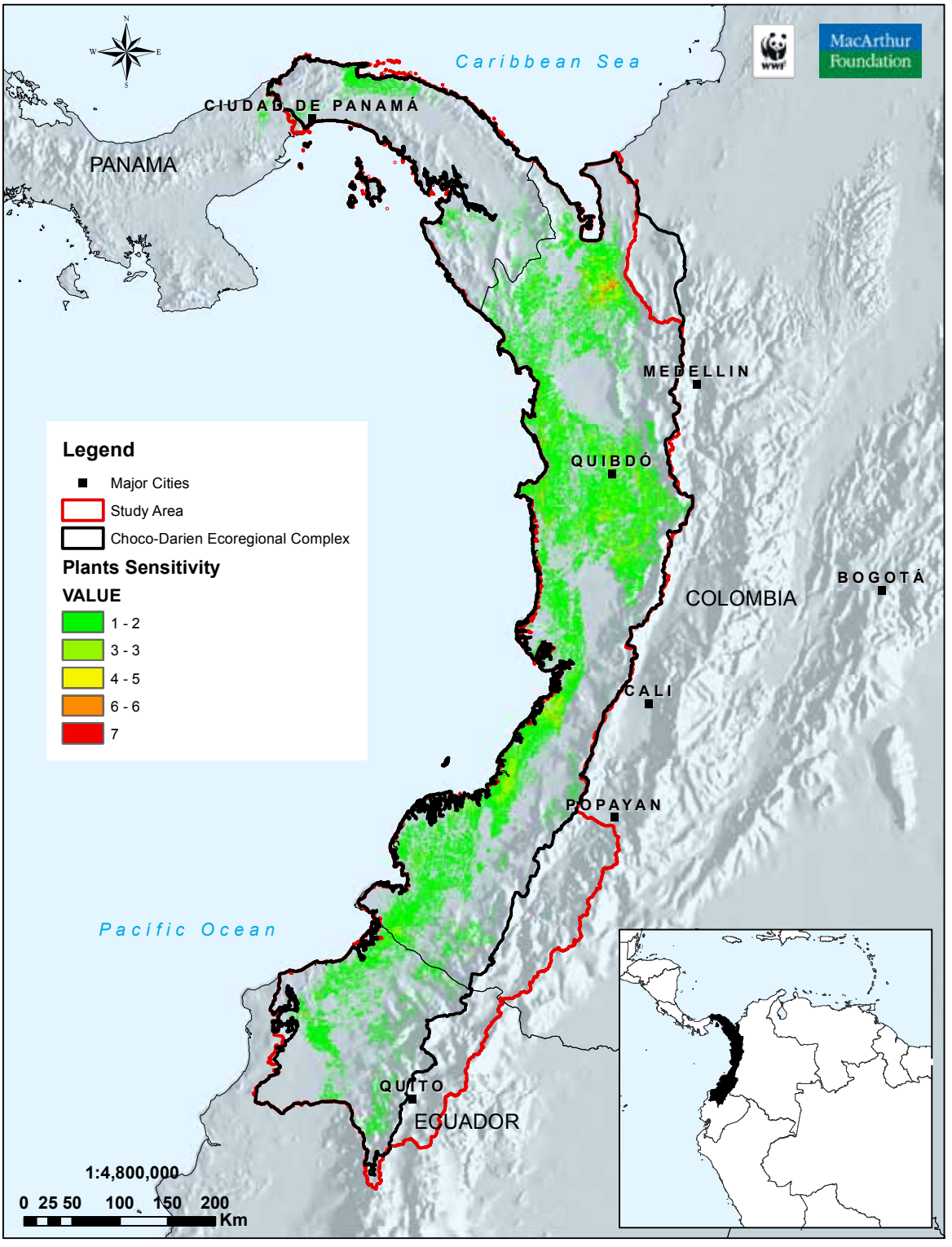


C Mammals climate change sensitivity 2050 (A2 scenario)



Map 13.
Climate Change sensitivity by taxonomic groups

d Plants climate change sensitivity 2050 (A2 scenario)



PRIORITY PORTFOLIOS

The prioritization exercise has generated a portfolio that can be considered at two levels: at site and wathersehed level.

At site Level

Conservation priorities were determined taking into account freshwater and terrestrial ecosystems and spices. Systematic conservation planning principles (Margules and Pressey 2000) were used as a framework for the application of criteria such as: representativity, irreplaceability, functionality, flexibility, vulnerability and connectivity. The use of optimization tools in systematic conservation planning has been widely used. For this case we use Marxan (Ball and Possingham 2002) algorithm to generate conservation priorities, meeting conservation goals at the lowest cost possible, priorizing those places where conservation targets are under a desired cost condition. This cost depend on biodiversity threats and climate change impacts on the distribution of species niches and ecosystem services. Drainage units (watersheds) were used as planning units.

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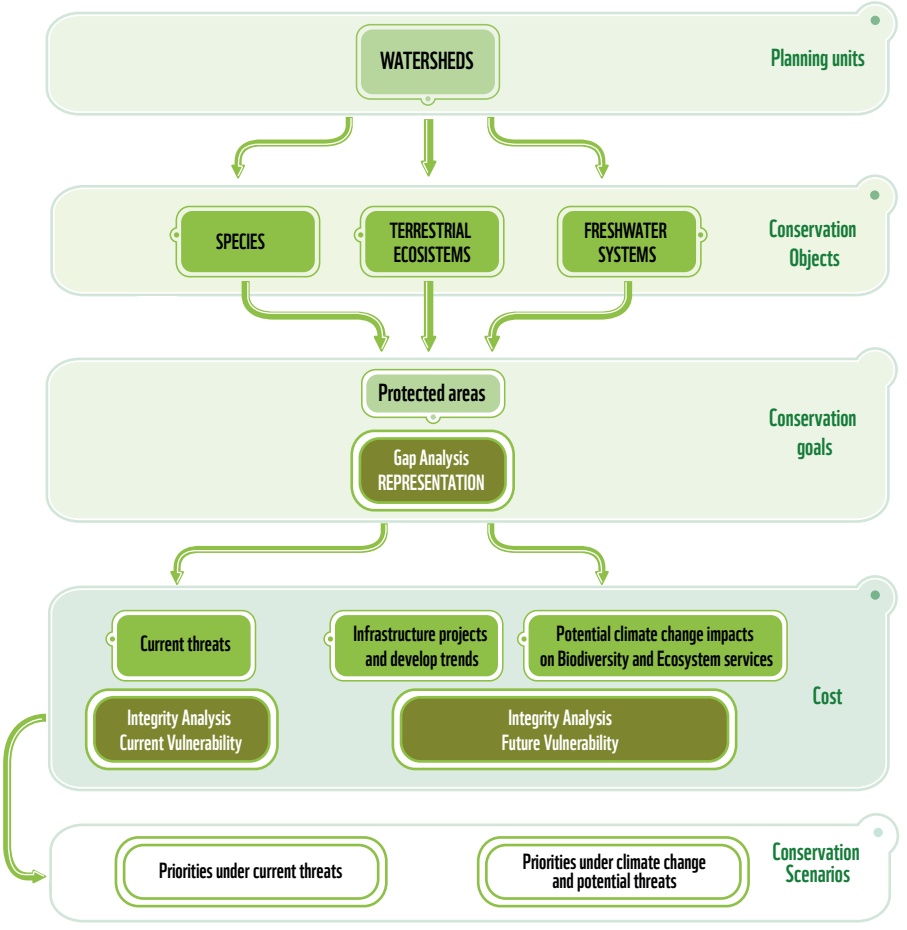
Graphic 6. Methodological approach diagram



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Conservation Targets

For the analysis of priority conservation targets we considered terrestrial and freshwater ecosystems and species richness.

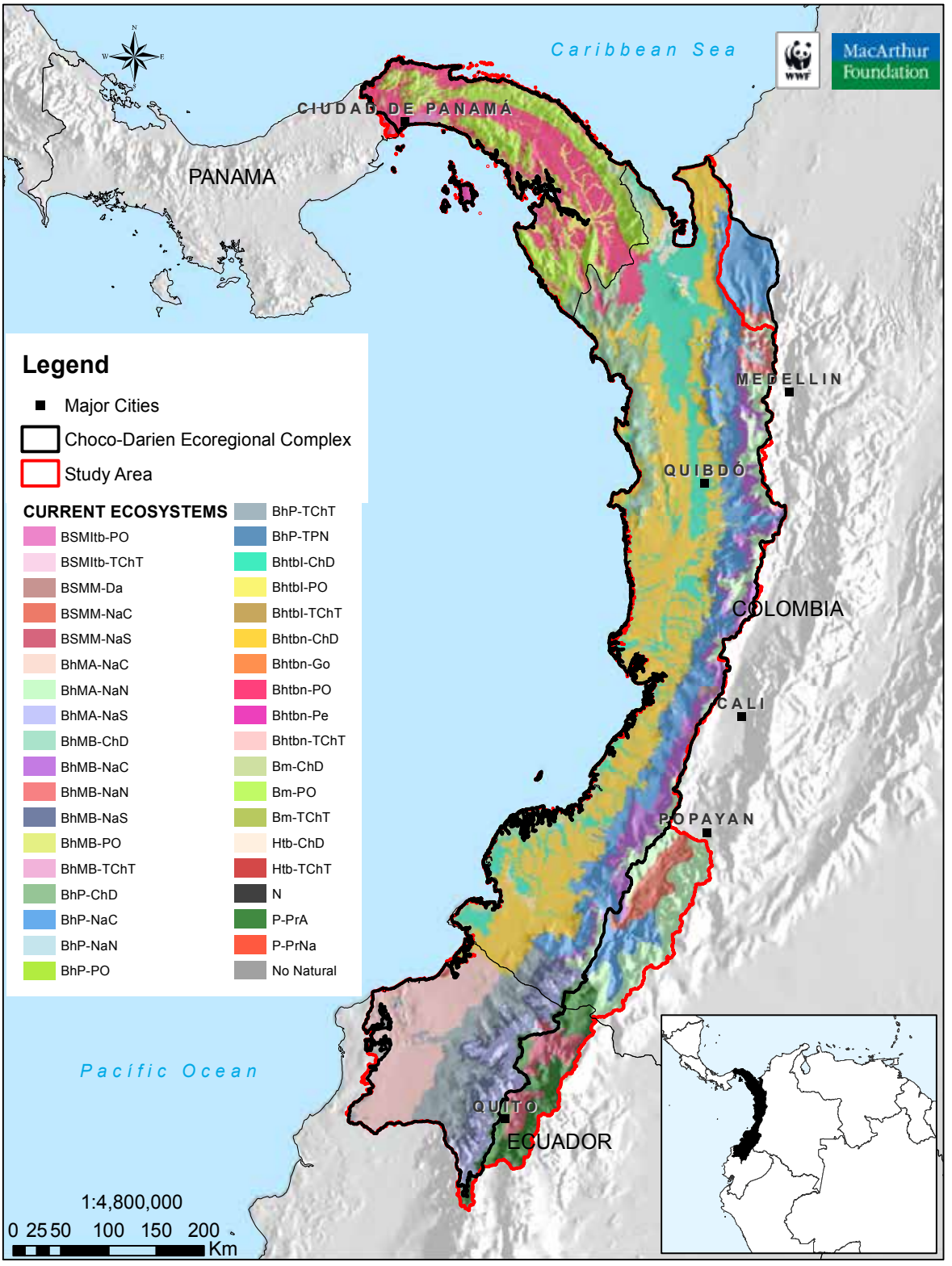
Threatened Species Richness

Species selection was based on the degree of threat defined by IUCN. Species distribution models, based on IUCN species lists were refined using the Space Land Change Model (Idrisi software) tool, that applies the algorithm Weighted Mahalanobis typicality (Wang 1990).

The results show that available information is still fragmented. Sampling localities are often separated by large areas without information and have a general tendency to be Nodeed in areas of greater access. Therefore, distribution models were enriched with the contributions of experts, community and institutional representatives who participated in the workshops for selecting conservation targets.

Natural terrestrial ecosystems

The terrestrial ecosystem approach is based on the biogeographical districts which are units with faunal and floristic compositions that share some similarity. We use the biogeographic units proposed by Walschburger et al. (2008, in WWF, ecotropic and Cecoin 2008), the original vegetation cover map for the Chocó-Darién (Gamboa, 2002), natural water bodies, and deforested areas.



Map 14. Natural Terrestrial Ecosystems

Freshwater heterogeneity

One of the most innovative elements of this analysis was the integration of distributional data for freshwater fishes into the ecoregional analyses. We made significant progress in consolidating information on the current state of knowledge of fish diversity in Chocó. This complements the watershed and ecosystem services prioritization exercise since it takes into account freshwater fisheries. Updating the list of freshwater fish for each basin of the Pacific and Caribbean coasts of Chocó-Darién was an exercise developed with the collaboration of different stakeholders including universities, NGOs, governmental institutions and research centers. The methodology proposed for the delineation of freshwater ecosystems took into account the developments of Higgins et al. (2005), Thieme *et al.* (2007) and Petry & Sotomayor (2009), and took into account the geology, slope, climate and environment of the river basins.

The information was systematized in a matrix relating all the information by watersheds, this matrix was used to produce maps of species richness, number of threatened species, number of endemic species, number of species with commercial value and number of migratory species. All data sets were validated in a ecoregional experts' workshop.

The Chocó-Darién Ecoregional Complex registered 264 freshwater fish species grouped in 88 genera, 33 families and 9 orders, which are distributed in the rivers of water springs that flow into the Caribbean Sea and the Pacific Ocean. The highest species richness were registered in the Atrato River basin (116 species), San Juan (96) in Colombia, and Tuira (72) in Panamá. This high diversity includes 63 species endemic to Colombia (33% of its wealth) mainly

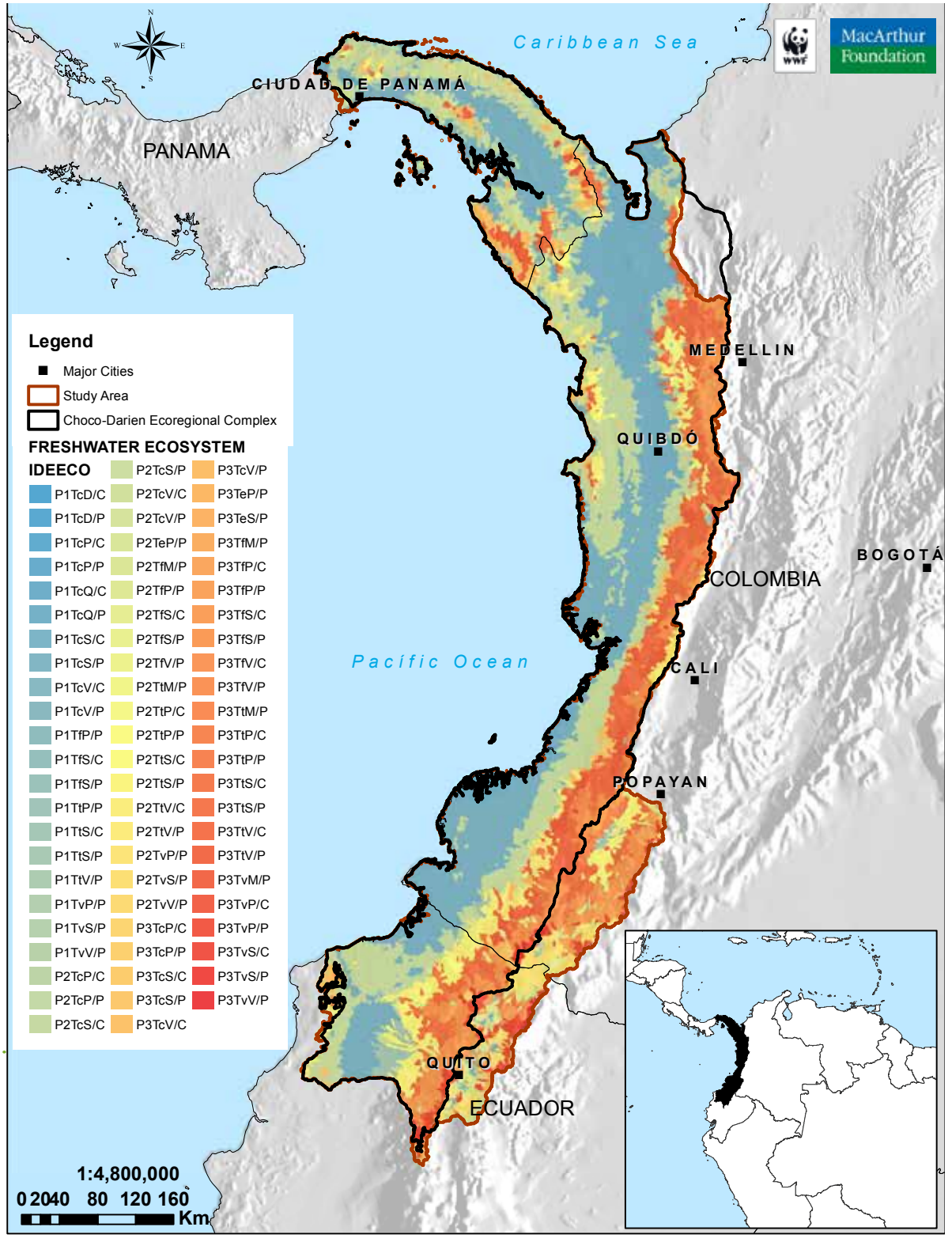
© Jorge García

Ageneiosus pardalis

© Armando Ortega-Lara

Prochilodus magdalenae

The Chocó-Darién Ecoregional Complex registered 264 freshwater fish species grouped in 88 genera, 33 families and 9 orders. The highest species richness were registered in the Atrato River basin (116 species), San Juan (96) in Colombia, and Tuira (72) in Panamá. Although it is imperative to increase the taxonomic and geographical sampling for this region.



Map 15. Freshwater heterogenity for the Chocó-Darién ecoregional complex

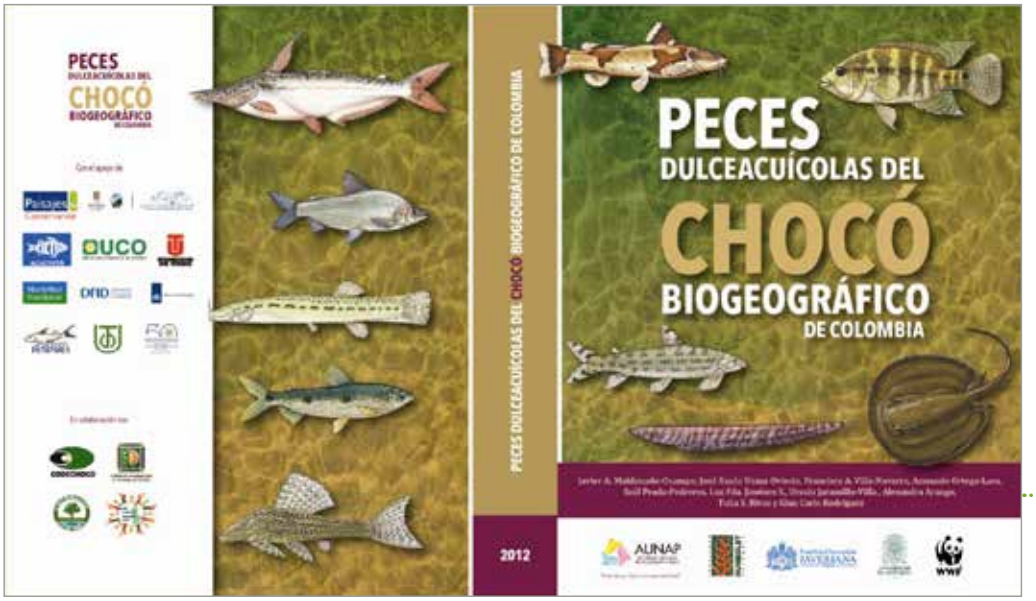
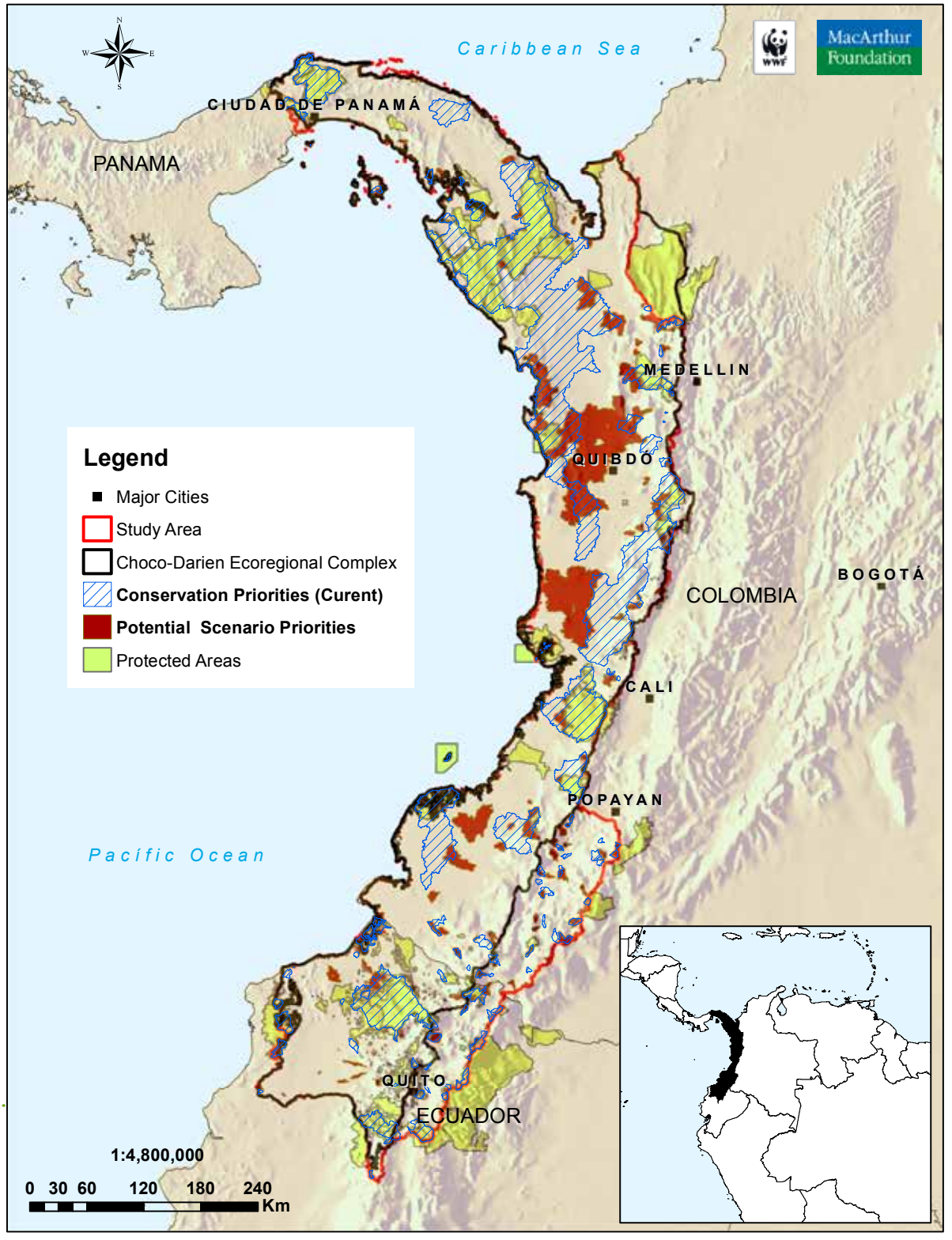


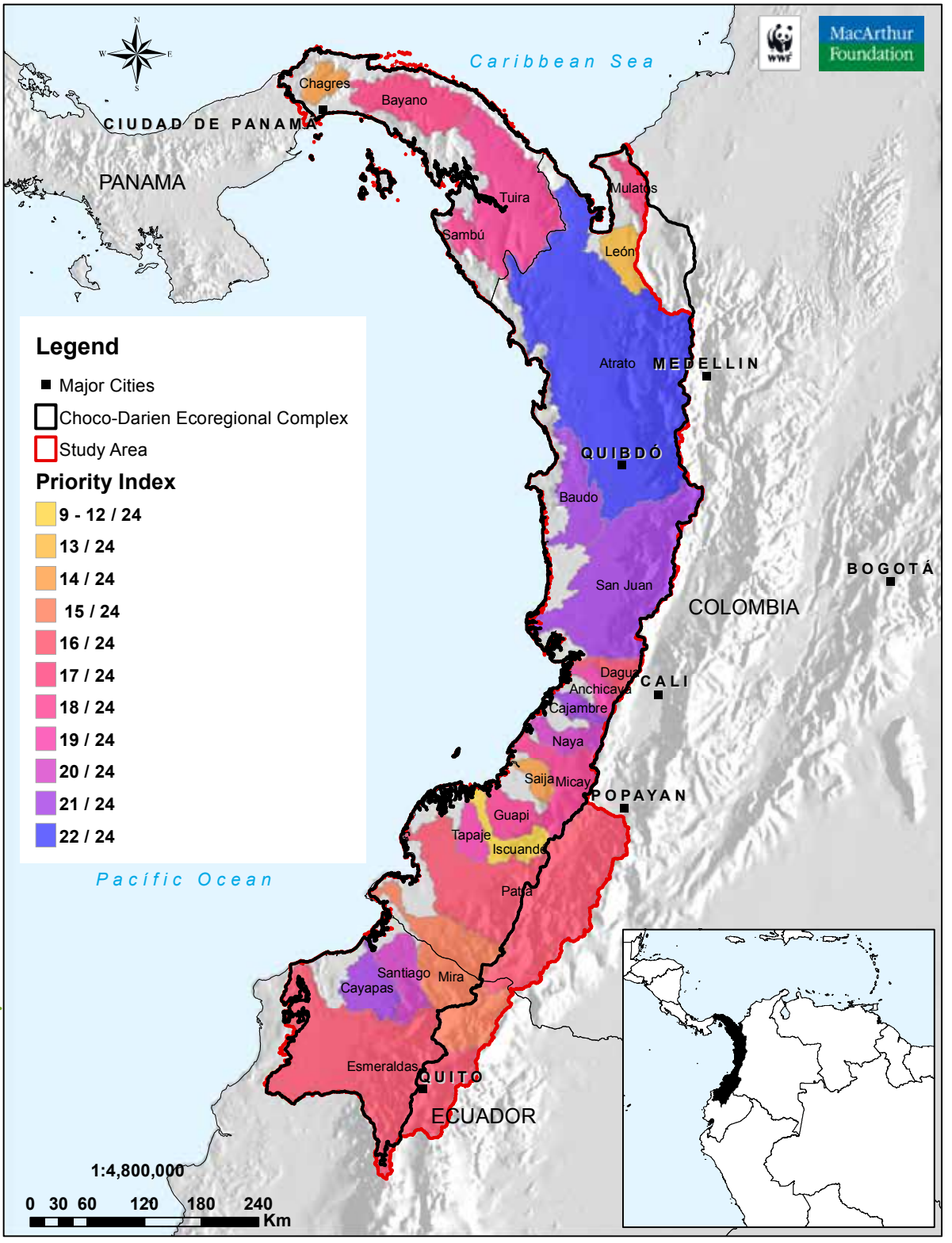
Figure 2. Freshwater fish for the Chocó-Darién (Colombia portion)

distributed in the Atrato River basin (12 species) and San Juan (5). In Colombia there are 30 species of commercial value that are highly endangered, as it is evidenced by the 15 species categorized in the Red Book of Freshwater Fishes of Colombia (Mojica et al. 2012.). Although studies that allow describing 16 new species have increased in the region during the past 15 years, it is imperative to increase the taxonomic and geographical sampling for this region. This must be done specially in the rivers of the Colombians Pacific slope, due to the fact that at the moment we only know the composition 25% of these rivers species. Otherwise, the process of fish extinction caused by agricultural development, infrastructure and mining activities, will economically deprive the poorest populations from their only source of protein and income and will alter key ecological processes such as migration and ictiocoria, Also, it will reduce the environmental heritage of Colombia, Ecuador and Panamá.

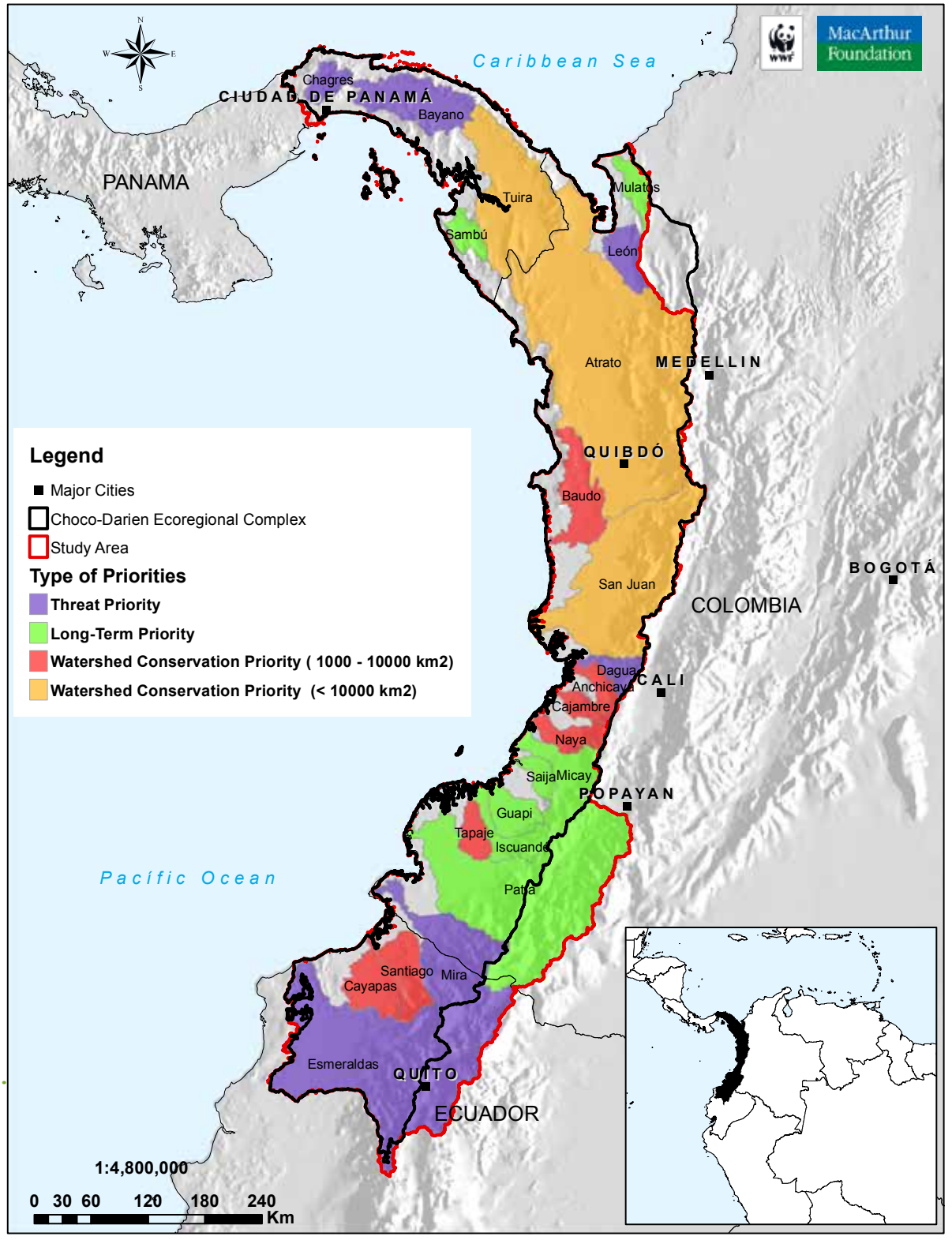
The consolidated information is a result of the coordinated effort led by the academic and research institutes (IIAP, IAvH and WWF) and it served as the basis to produce the book *Fishes of the Chocó biogeographic region of Colombia*. This text is an important contribution to the knowledge and understanding of this fish group. Furthermore, for the first time this species analysis was integrated to an exercise of prioritizing areas for conservation in the Chocó-Darién.



Map 16. Priority Conservation Portfolio at site level



Map 17. Watersheds portfolio priorities for the Chocó-Darién ecoregional complex levels X and Y.



Map 17B. Watersheds portfolio priorities for the Chocó-Darién.

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Priority Portfolio at watershed level

The second portfolio was produced during the workshops and includes qualitative analysis for each watershed, based on their importance for the provision of ecosystem goods and services, the level of integrity, the presence of threatened species and species richness, ecological representation, presence of cultural and community based processes and the existence of conservation or management processes. These criteria were ranked in three levels (high, medium and low) and summarized in a priority index as the sum in relation to the maximum value.

Absolute importance for 22 watersheds was rated according their capacity of provision of goods and ecosystem services, the level of ecological integrity, threatened species richness, the representativeness or conservation needs, the cultural and institutional and/or community conservation processes on going:

- Ecosystem goods and services[3]
- Integrity (current and future)
- Presence of threatened species
- Need of representation and / or conservation
- Sensitivity to climate change
- Cultural importance and community processes underway
- Institutional processes in place

3. We used quantitative information generated for each of the watersheds as water supply, sediment retention and carbon storage and additionally was considered the qualitative information provided for aspects such as scenic beauty and ecotourism, and timber and non-timber products.

Developing a framework to influence policy definition and decision making at the national and regional levels

Support for the design of an adaptation strategy for the Chocó-Darién: actions related to the national agendas on climate change and REDD were supported by work in the definition of the National Adaptation Strategy in Colombia, through discussions and inter-agency working agendas by the following processes:

- R-PP National REDD Strategy. Social and Environmental Assessment - SESA: This process, led by the Ministry of Environment and Sustainable Development, is part of the actions that must be advanced to support the preparation of the National Strategy for Reducing Emissions from Deforestation and Degradation - REDD+, and engage key stakeholders related to forest management and conservation.
- Communication strategy design for REDD+ in Colombia: The national roundtable on REDD+ seeks to increase awareness and strengthen the capacities of indigenous peoples and peasant communities in relation to REDD and forest carbon projects, so they can take better and informed decisions about these opportunities.
- The decision of the Ministry of Environment and Sustainable Development (MADS) to prioritize the development of a national REDD+ social and environmental safeguards framework was an important result of the process of strengthening capacities of indigenous and afro-Colombian communities in participation and decision-making related to REDD+, that has been led by WWF and Patrimonio Natural (as member organizations of the REDD+ Roundtable). The decision of the government was to build this system not from a top-down approach, but using local processes and gathering their feedback, in order to develop a more inclusive course of action.

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The activities described above have been implemented in coordination with the Conservation Incentives Project led by the Ministry of Environment and Sustainable Development and the Fondo Patrimonio Natural with support from the Kingdom of the Netherlands, in partnership with WWF Colombia.

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Ecosystems services, livelihoods and conservation incentives

A detailed analysis of watersheds was performed in order to develop a preliminary proposal of possible incentive schemes to enable the implementation of productive activities. This aimed to improve the livelihoods of local communities and help to desing climate change mitigation and adaptation mechanisms while contributing to maintain the future provision of ecosystem services in those watersheds.

The basins considered for this exercise were Bayano and Chucunaque in Panamá, the upper and lower Atrato River and Guapi basins in Colombia, and the binational Colombian Ecuadorian Mira Basin. For each case, major productive activities were characterized, including mining, fisheries, livestock production systems, and agriculture and forestry production systems. An economic analysis was carried out for these activities including revenues, costs and production volumes. We sought to prioritize activities with the greatest impact on environmental services in order to develop a proposal for incentives that would be considered in actions that promote the conversion of production systems to more sustainable alternatives.

In parallel, an approach of the computing of the economic value of ecosystem services was obtained. Assigning economic values of ecosystem services was obtained using both the criteria defined in the study *The Economics of Ecosystems and Biodiversity* (TEEB, 2007) and the values given to the threats that generate ecosystem services loss in each basin, according to the range of severity established in the prioritization exercise described in objective one.

We also characterized business models for the main productive activities in the region and the types of capital involved therein, posing potential incentive proposals for each of the watersheds, including projects on REDD, payment for ecosystem services (PES), FSC, Rainforest Alliance Certified, Gold and RSPO Certification.

Aiming to focus the analysis on those production systems that generate the greatest loss of value, we examined the relationship of prioritized environmental services (water provision, sedimentation control and carbon capture), in each of the selected watersheds. The analysis was developed taking into consideration the type of productive activities that were identified and prioritized, regarding the loss of value of ecosystem services.

ACHIEVEMENTS

Environmental and socioeconomic information for the Chocó-Darién Ecoregion Complex is updated with high quality data. It provides innovative information on ecosystem services that can be used to desing am ecoregional climate change plan. Additionally, it enhances knowledge and improves ichthyological research and its relation to the wellbeing of local communities and society in general.

With support from MacArthur Foundation WWF Colombia has developed a number of adaptive interventions around four specific objectives:

1. Updating existing assessments of pressures and threats to biodiversity in the Chocó Darién Ecoregional Complex and defining the vulnerability of ecological and social systems in the region to climate change.
2. Identifying priority watersheds and ecosystem services in the Chocó Darién Ecoregional Complex where climate smart landscape management plans must be designed.
3. Developing a framework to influence policy definition and decision-making at the national and regional levels.
4. Identifying research priorities for the Ecoregional Complex to advance our understanding of the connection between ecosystems services and livelihoods and the most effective means for structuring potential incentive mechanisms.
5. The project allowed WWF to work closely with institutions responsible for the production and management of scientific information, research institutes and universities. The project also engaged other NGOs and the civil society in the process of updating and analyzing the current and potential anthropogenic pressures in Chocó-Darién's natural ecosystems and their vulnerability to climate change. The results provide fundamental information to support the design of an ecoregional adaptation strategy for the Chocó-Darién. Several stakeholders are using this information in different processes. The main achievements for each of the four objectives of the project are detailed below.

CHALLENGES

The work in Chocó-Darién faced several challenges:

Recent Institutional restructuration in both in Colombia and Ecuador opened new opportunities to improve environmental governance. The creation of the Ministry for Environment and Sustainable Development in Colombia, the National Agency of Hydrocarbons (oil), Mining and Cooperation, the creation of the National Fisheries Authority AUNAP, and the expansion of the jurisdiction of the regional environmental authorities to the coastal marine areas, were some of the most important institutional reforms favoring natural resource governance. However, the process of institutional adaptation and development of action plans meant management limitations and demanded more time than expected for the activities planned.

Usually, institutions are weak in the region. However, some integration efforts at the sectoral level have been made in order to develop regional initiatives such as the SIRAP Pacifico, the Climate Change Node for the Pacific region, GEF-SAMP, among others. Even though these initiatives face major challenges they are a way of integrating both agendas and technical, human and financial resources. avoiding dispersion of efforts.

From a technical point of view, gaps in species data limited the scope for the application of modeling tools. Therefore, it is necessary to continue research efforts in order to cover information gaps on priority areas, and to improve biodiversity knowledge and to have better information for the design of conservation strategies in the ecoregion.

Regarding Objective 4, it should be noted that the information obtained with the compensation schemes was not complete enough since it was largely based on estimates. The informality and illegality that characterizes many of the business transactions in the region doesn't permit us to calculate precise values for the services analyzed, or at least, one close to the economic trends in the region. Therefore, our results about the value of ecosystem services for priority watersheds have to be interpreted with caution.

LESSONS LEARNED

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The information obtained in the Chocó-Darién analysis is a major input that can be used to in the binational agendas between Colombia and Ecuador and Colombia and Panamá. This information is expected to help to streamline plans, programs and projects defined in binational cooperation agendas. In the case of the Mira Basin, WWF was invited by the Ministry of Environment and Sustainable Development of Colombia, the Government of Nariño and the Nariño Environmental Corporation (CORPONARIÑO) to participate in the First Binational Forum for Transboundary Basin Management in Colombia and Ecuador. In this event, the results of the analyses performed in the framework of the project were presented. At the moment, the results are being evaluated in order to define a work plan with national and regional environmental authorities in each country. WWF has also participated in the V Colombia Ecuador Binational Forum (see details in http://www.forobinacional.org/).

The opportunity to assemble interagency and multisectoral workspaces and to include regional players allowed to share different approaches, visions and proposals at a policy level. Also it allowed to develop plans within the ecoregion and to identify challenges and opportunities. To face those challenges joint efforts to establish strategic alliances will allow us for leverage common efforts in the region.

Funding incentive schemes largely depend on market instruments. This demands greater responsibility of the private sector in the marketing of products from areas of high biodiversity, using existing labels and certifications. Economic instruments could allow building schemes to establish relations between suppliers and demanders of environmental services. The experiences in carbon capture and water supply have to be considered for this type of environmental services.

THE WAY FORWARD

Due to its exceptional environmental, ecological, socio-economic and cultural characteristics, the Chocó-Darién ecoregional complex is an area of global importance with a privileged role in the development agendas of the three countries that are part of it.-Every effort aimed to increase the visibility of this key ecoregional complex must be favored. Urgent actions to enhance the influence strategy in areas such as mining, rural development law, climate change and REDD+, among others must be supported.

Partnership and stakeholder's collaboration

Project actions have been implemented in coordination with various institutions, community and civil society. Promoting processes coordination, resource optimization and the establishment of synergies and concerted agendas will allow the projection and sustainability of actions in the short, medium and long term. In this sense, the project has contributed to the consolidation of planning and production of technical products of regional and national interest.

The results presented here are useful to enable a common agenda. They contribute to the management of priority watersheds maintenance of biodiversity, ecosystem services and improvement of livelihoods conditions with active participation of different stakeholders of the Chocó-Darién.

The project has contributed directly or indirectly with information and strategic alliances that will strengthen conservation processes in the three countries of the Chocó-Darién Ecoregion (Panamá, Colombia and Ecuador). During the process at least 29 public institutions at national or regional level, 15 community organizations, 19 NGO's, 13 academic and research institutes and 9 international cooperation agencies and/or programmes have participated in the project's activities. Additionally, WWF has strengthened/ established strategic partnerships with approximately 74 key stakeholders. The strategic partnerships established and the social and organizational processes that have started in the region are the basis to increase sustainability, conservation activities and to reduce impacts in the medium and long term.

Country	Protected areas category
Colombia	Special Management Area (Afrocolombian)
	Special Management Area (Indigenous)
	Integrated Management District
	Municipal Natural Park
	National Natural Park
	Regional Natural Park
	Special Forest Reserve
	National Forest Reserve
	Protective Forest Reserve
	Regional Forest Reserve
	Nature Reserve
	Civil Society Natural Reserve
	Municipal Natural Reserve
	Galeras Flora and Fauna Sanctuary
	Ramsar site

Country	Protected areas category
Ecuador	Individual Conservation Area
	National Recreation Area
	Community Protected Areas
	Protector forest
	Patrimony Forest
	Ecological Reserve
	Reserve Geobotany
Panama	Recreation Area
	Biological Corridor
	wetland
	Natural monument
	Protected Landscape
	National park
	Natural park
	Wildlife Refuge
	Forest Reserve
	Hidrologic Reserve
	Hidrologic Protection Zone

In collaboration with:

FORO INTERÉTNICO SOLIDARIO CHOCÓ

CODECHOCÓ

autoridad nacional del ambiente

Ministerio del Ambiente

Universidad Tecnológica del Chocó "Diego Luis Córdoba"

ANCON

IDEAM Instituto de Hidrología, Meteorología y Estudios Ambientales

IIAP Instituto de Investigaciones Ambientales del Pacífico

ETESA Empresa de Transmisión Eléctrica, S.A.

ALTROPICO

4D Elements Consultores