The Importance of Protected Areas in Mitigating Climate Change and Conserving Ecosystems in Latin America and the Caribbean

Cristián Bonacic, Constanza Arévalo, José Tomás Ibarra, and Jerry Laker

Abstract Biodiversity conservation in a world under climate change is a significant challenge for Latin America and the Caribbean (LAC), which holds 60% of global terrestrial life. Six of the ten most biodiverse countries (Brazil, Colombia, Ecuador, Mexico, Peru, and Venezuela) are in LAC, and biodiversity hotspots are well-represented along the region's coasts and mainland. The region has the most significant areas of tropical forest and large portions of subtropical forests, temperate steppe, and subantarctic Patagonia. Protected areas offer opportunities to conserve unique biodiversity, provide ecosystem services, and mitigate climate change effects. LAC's contribution to carbon capture, by protecting extensive forests and other natural ecosystems, is potentially opening tremendous economic opportunities under the green economy paradigm. This chapter describes the current status of protected areas in LAC and explains how this conservation mechanism should play a mitigation role. LAC's protected areas cover almost all types of terrestrial and marine ecosystems, and their number is increasing in the region. Although protected areas mitigate

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the effects of climate change on biodiversity, climate change and traditional environmental problems like deforestation, mining, and agriculture affect the viability of protected areas. Thus, their expansion and connectivity throughout the region are crucial to combat climate change and biodiversity loss. Nature is also essential to the region's biocultural diversity, including a miriad of complex cosmovisions and traditions. In LAC's unique ecosystems, rich biodiversity is spatially correlated with rich cultural diversity, granting opportunity for Indigenous Peoples and Local Communities to lead experiences in managing protected areas in biologically and culturally diverse ecosystems of LAC.

Keywords Biodiversity · Climate change · Conservation · Latin America · Protected areas · Sustainable development goals

1 Introduction

Latin America and the Caribbean (LAC) is one of the ecologically richest regions in the world, considering terrestrial and marine biodiversity, holding about 60% of the world's terrestrial life forms (UNEP-WCMC 2016). Latin America includes Mexico (the south of North America), central or Mesoamerica, and South America (total area: 20 million km^2) and comprises 13% of the world's land area. Latin America has the most significant portion of tropical rainforest and large quantities of subtropical forests, temperate steppe, and subantarctic Patagonia. Six out of the ten most biodiverse countries globally are found in Latin America (Brazil, Colombia, Ecuador, Mexico, Peru, and Venezuela). South America alone is the most biodiverse region on Earth, holding over 40% of the world's biodiversity and over 25% of the world's forests (Álvarez Malvido et al. 2021).

The distribution of protected areas in Latin America covers almost all terrestrial and marine ecosystems, from coral reef barriers in Mesoamerica to tundra-like ecosystems in Tierra del Fuego (Patagonia). Some countries have a more significant proportion of their lands covered by protected areas, and others have less. Still, the growing number of new protected areas has become a common trend throughout the region. Biodiversity hotspots are well-represented in Latin America along coasts and on the mainland. Over 10,000 marine and terrestrial protected areas throughout LAC protect over 8.8 million km^2 of land and water, which makes it the most protected region in the world, with 24.21% of the region's terrestrial surface area and 23.02% of its marine and coastal area under protection (UNEP-WCMC 2016). Over 60% of the region's protected areas are found in South America, comprising one-quarter of the region's terrestrial surface area and one-quarter of the region's marine and coastal surface area.

The LAC population was 662,157,288 in 2021, based on the United Nations' estimates (32 people per km^2). This is equivalent to about 8.42% of the total world population, making LAC the fourth most populated region in the world. A common feature of most Latin American countries is that people live in large metropolises,

accounting for 82.5% of the total population. Massive movements of people from rural to urban areas occurred in the last 50 years, particularly during this century (Dufour and Piperata 2004). Latin America has cities with over 20 million people in Mexico and Brazil (Ciudad de Mexico and Sao Paulo), cities with close to 15 million inhabitants (Buenos Aires and Rio de Janeiro), and several with around ten million people (Lima and Bogota).[1] The three most significant populations are in Brazil (over 212 million people), Mexico (over 120 million people), and Colombia (around 50 million people). The vulnerability to climate change is high for large concentrations of people living in cities along the coastline, like Panama (Ciantelli et al. 2018), Rio de Janeiro, and Buenos Aires (Codignotto et al. 2012; Mascayano et al. 2021; Zambrano et al. 2017). Also, torrential rain, floods, and landslides are risk factors for large cities like Bogota and Quito (Lima Guamán et al. 2020), Sao Paulo, and Santiago of Chile (de Lima et al. 2018). Meanwhile, drought and glacier disappearance are a significant threat to human access to freshwater (Chevallier et al. 2011). The central Andes are the only tropical region of the world that depends on glacier melting for freshwater supply to large cities (Buxton et al. 2013). Quito in Ecuador, Lima in Perú, and La Paz in Bolivia are dependent on vanishing glaciers that are melting due to climate change (Buxton et al. 2013). Santiago of Chile is also a city that depends on glaciers for sustained water supply and has endured more than a decade of drought and more frequent heatwaves affecting over 7 million peoples' livelihoods (Borgias 2016; Palmeiro-Silva et al. 2020; Vicuña et al. 2018).

Another significant effect of climate change is the increased variability of harvest production. Rice, wheat, corn, beans, and soybeans play an essential role in Latin America due to their economic contributions and food security. According to Rodríguez De Luque et al. (2016), climate change affects how crops grow, adapt to higher temperatures, and less or more variable rainfall (i.e., off-season storms). Food security is an emerging concern in Latin America as the population grows and crop production levels off or declines in the region (Rodríguez De Luque et al. 2016).

This chapter describes the wealth of biodiversity and the importance of protected areas for climate change mitigation and adaptation in Latin America. We relate human population protection, access to a green economy, and more stability in a changing world if inclusive protected area coverage increases. Protected areas and nature conservation are included in the coming equation of sustainability, environmental justice, and economic growth. We emphasize why protected areas are a key element to achieve Sustainable Development Goals (SDGs). Finally, the cultural, ancestral, and non-economic values of sacred natural places and biodiversity are discussed. Living examples of conservation, community-based work for climate change mitigation, and biocultural heritage are presented as a proposition of a broader view of mitigation that embraces ecological, economic, and cultural challenges.

[1] Population by Country (2021)—Worldometer (worldometers.info).

2 Climate Change in Latin America

Latin America is particularly vulnerable to climate change, whose impacts are causing biodiversity loss, food insecurity, and economic problems (Fierros-González and López-Feldman 2021). The physical and geophysical impacts of climate change are expected to compound with one another, making their influence even more severe in the region, likely accentuating Latin America's vulnerabilities (Reyer et al. 2017). The most significant ocean warming is occurring in the southern hemisphere, increasing weather variability and the intensity of storm episodes, prolonged droughts, and the deterioration of border coastlines. Hurricanes have become more intense and frequent, threatening food security and increasing disease prevalence (Laffoley and Baxter 2016). Temperatures in 2020 were 1.0 °C, 0.8 °C, and 0.6 °C above the 1981–2010 average for Mesoamerica, the Caribbean, and South America, respectively (WMO 2021). Global warming is a concern when freshwater supplies are threatened by the rapid melting of glaciers in the Andes of western South America, impacting drinking water and irrigation water supply (NASA 2020). While larger glaciers in the southern Andes are predicted to melt at a slower pace, tropical glaciers are decreasing rapidly, and total melting is likely to occur under high warming levels (Reyer et al. 2017). Nonetheless, glaciers in the Chilean and Argentine Andes have been retreating during the last decades, with ice mass loss accelerating since 2010 (WMO 2021).

Key biodiversity hotspots are located along the Andes, with a large human population and agricultural activities. Frequent and more destructive hurricanes, torrential rains, prolonged droughts lasting more than a decade, dry lightning storms causing forest fires, and heatwaves have become common features in the region. On a global scale, the intensity of tropical cyclones is expected to increase by about 5%, and the proportion of higher intensity storms (categories 4 and 5) is expected to rise by 13% (Knutson et al. 2019). The role of coastal protected areas for mangrove forest conservation is becoming one of the most important arguments to foster protection in the Caribbean region. Countries like Cuba that protect coastal mangrove forests respond better to hurricanes than other countries where biodiversity and coastal areas have deteriorated, such as Haiti (Alscher 2011; López and Rodriguez 2018). Storms have been responsible for human displacement and land-use changes, adding pressure for natural areas to be converted into human settlements and agricultural land. Droughts are also widespread in the region, with many Latin American countries on the global list of the most water-stressed countries in the world (Hofste et al. 2019). Chile is the most vulnerable and highest-ranked Latin American country on the list, ranked 18th globally, and is currently facing a prolonged drought lasting over a decade. The Mediterranean Forest, located between 32° and 37° S latitude, is a unique 1000-km-long ecosystem along the western side of the Andes (Veblen et al. 2007), occurring between the driest desert in the world (the Atacama desert) and the temperate rainforest of southern Chile (Nadjar et al. 2007). Climate change is affecting this region with a decade of drought, causing the forest and shrublands to die

out because of this prolonged condition. This ecoregion is a unique environment with high endemism. Many species of flora and fauna under threat by intensive agriculture are now experiencing added pressure from climate change acting on ecosystems and humans.

Similarly, unusually long dry periods affect the Amazon basin in Brazil and Mexico, with the 2020 drought in southern Amazon and the Pantanal being the worst in 60 years (WMO 2021). In the case of the Amazon basin, the ecosystem is believed to reach a tipping point when it reaches 40% deforestation, decreasing precipitation and shifting the regional climate to a warmer and drier one. The ecosystem would change from tropical rainforest to savanna (Sampaio et al. 2007). Irresponsible land-use change causing widespread deforestation, prolonged droughts, and heatwaves have aggravated the already fast decline of the native forest not only in the Amazon but also in the Paraguayan Chaco and the Pantanal region, one of the most extensive wetland ecosystems in the world and the most diverse in Latin America.

Amid the inevitable and detrimental impacts of climate change, protected areas can maintain biodiversity by minimizing these impacts. Climate change drives changes in wildlife distribution ranges. Also, habitat loss and degradation often impede migratory movements. Therefore, protected areas play an essential role in reducing the effects of climate change by providing wildlife with the space to adjust to rapidly changing climatic conditions (Lehikoinen et al. 2018). Increased protected area connectivity is crucial for the persistence of biodiversity as species' composition adapts to climate change, especially considering the expected severity of climate change impacts in Latin America. Strictly protected areas are common along country borders in Latin America. They are often clustered, creating high coverage and connectivity (Baldi et al. 2017; Thornton et al. 2020), making these regions particularly important for biodiversity conservation. Thornton et al. (2020) found clustering of protected areas near country borders in Argentina, Bolivia, Costa Rica, and Guatemala.

Deforestation rates within protected areas tend to be significantly lower (Leverington et al. 2010; Nagendra 2008). Tropical protected areas in the Americas, Africa, and Asia were found to have decreased carbon emissions by about 29% between 2000 and 2012 in comparison with expected rates of deforestation (Bebber and Butt 2017). However, recent data about Amazon deforestation is alarming. Ruiz-Vásquez et al. (2020) suggest that deforestation affects the climate in the entire region as atmospheric water evaporation is now altered as predicted 30 years ago (Shukla et al. 1990). The leading causes of deforestation remain the same, and the rate of deforestation is stable, bringing the Amazon to a tipping point of becoming a carbon emitter instead of the main carbon sink (Amigo 2020; Lovejoy and Nobre 2018). Cattle, road networks, human population growth, logging, and increased habitat replacement for crop production are the determinant variables of deforestation in the Amazon (de Andrade Vasconcelos et al. 2017). Forest loss in the Amazon affects the precipitation regime locally and elsewhere (Río de La Plata basin) in Argentina and Paraguay. One alternative solution to protect the Amazon Forest is the creation of new protected areas in the southern and southeastern basins where a semiarid forest acts as a barrier for further deforestation caused by climate change (Walker et al. 2009).

Beyond the Amazon and Río de La Plata basins, one of the largest rainforests of Latin America is now under threat in the Choco-Darién biodiversity hotspot—an area of more than 17 million square kilometers that is highly biodiverse. It includes 7500 species of plants (of which 1300 are endemic), 700 butterfly species, and more than 1500 bird species (Gomez et al. 2014). Its strategic location joins migration routes between north and south America and is one of the 25 most critical hotspots in the world. The Choco-Darien Global Ecoregion is the second-largest continuous rainforest in Latin America and includes southern Panama, the Colombia Andean region, and the north of Ecuador. Patterns of deforestation are closely related to agriculture, roads, and negatively correlated with country-level economic development. Wealthier areas are conserving/recovering more forest, and rural to urban migration releases pressure on deforestation (Fagua et al. 2019). Lastly, another critical and significant continuous rainforest of Latin America expands from the Yucatán peninsula in Mexico to Guatemala and Belize (known as the selva Maya). The tropical rainforest, which accounts for 14 million hectares, is home to the Maya culture and is the last remaining forest in the rich Mesoamerica biodiversity hotspot. As in the Choco-Darien and Amazon rainforest, deforestation and climate change affect these highly biodiverse ecosystems. Human pressure for opening the land to agriculture and roads, the tourism industry, and infrastructure are common threats for all of them.

Terrestrial protected areas worldwide store a large amount of carbon believed to be about 15% of the world's terrestrial carbon stock (Kapos et al. 2008). Out of all the regions in the world, LAC holds the second-largest amount of carbon in protected areas relative to the region's total carbon stock, with South America storing about a quarter of the entire region's carbon (Dudley et al. 2010). If we consider Central America and the Caribbean together, protected areas store 25.2% of the region's total carbon stock. The most significant and effective terrestrial carbon sequestration occurs in forests, including tropical forests seen throughout the Latin American region, particularly the Amazon rainforest, and temperate forests seen in Chile and Argentina. Almost three-quarters of the total area of humid tropical forest protected areas are in South America (Tabor et al. 2018); a region that is not only responsible for significant carbon sequestration but a high concentration of biodiversity. The Collaborative Partnership on Forests has long recognized the need to protect these forests by implementing protected areas, claiming that protected forest areas increase the resilience of ecosystems to climate change, protecting against climate change and adaptation through genetic resources and ecosystem services (CPF 2008).

While a case can be made for the importance of protected areas in mitigating the effects of climate change, the opposite is also true. Protected areas can be severely threatened by climate change, particularly when discussing marine protected areas worldwide. Well-managed marine protected areas can preserve marine ecosystems against the impacts of climate change and prevent acidification, decreased oxygen availability, sea-level rise, changes in species distribution, and the intensification of storms (Roberts et al. 2017). Nonetheless, due to ocean warming, acidification, and oxygen depletion, the habitats and species that marine protected areas are meant to protect will continue to be threatened, particularly in low-latitude and tropical regions (Bruno et al. 2018; García Molinos et al. 2015; Stuart-Smith et al. 2015),

thus reducing the effectiveness of marine protected areas in mitigating the effects of climate change. The same applies to protected areas under the impact of climate change that are likely to see reduced effectiveness in safeguarding endangered habitats and biodiversity. Consequently, protected areas, both terrestrial and marine, will need to adapt to the ecological changes resulting from climate change. 42% of South American protected areas covering humid tropical forests are exposed to the highest novel climate risk, causing much uncertainty regarding the ability of species inhabiting the region to adapt to new climates and, therefore, to continue to be protected by these areas (Tabor et al. 2018). As a result, increasing connectivity among protected areas throughout the humid tropical forest region and other regions in Latin America is crucial to ensuring the continued protection of biodiversity as climate change shifts species distributions.

3 The Importance of Protected Areas in Latin America and Climate Change

Latin America spans multiple ecosystems, and its vulnerability to climate change is extremely high (Locatelli et al. 2011; Rodríguez De Luque et al. 2016). Local communities and scientific evidence suggest that climate change is changing the way of life, affecting food security, and decreasing biodiversity viability in multiple ecosystems (Iwama et al. 2021; Reyer et al. 2017). Climate change is causing sea-level rise, rising temperatures, land and forest degradation, salinization, loss of biodiversity, ocean acidification, desertification, and glacial retreat. Extreme weather events affect millions of people in cities and cause crop failure in vast regions of Latin America. Mainly, several million people live in the path of hurricanes and low-elevation coastal zones, rendering them vulnerable to sea-level rise, storm surges, and coastal flooding (Reyer et al. 2017).

In summary, the challenges coming from climate change affect human health, food production, and human settlement in unsafe areas, caused by coastal degradation, fisheries loss, biodiversity loss, and forest degradation, and contribute to global change. One example is the Amazon Forest, which is reaching a tipping point as deforestation increases its vulnerability to climate change. Hall (2011) stated the importance of protected areas to confront the diversity of challenges that climate change generates either in marine or terrestrial ecosystems of LAC. However, island sinking, coral reef decline, lower fishery production, and intense and more frequent forest fires compromise the viability and interconnection of protected areas in Latin America. Gámez et al. (2018) stated the importance of conserving protected areas and adapting to climate change by managing protected areas with local communities. The recovery of nature and closing the gap between people and nature have many advantages, from increasing quality of life to protecting biodiversity and capturing

carbon. The latter is becoming an urgent need as climate change is causing ecological, economic, and social damage worldwide.

The concept of a "green economy" was introduced in the Conference of Sustainable Development Rio + 20 and refers to an economy that is low carbon, resource-efficient, and socially inclusive (UNGA 2012). A green economy under the sustainability paradigm results in improved human wellbeing and social equity, while significantly reducing environmental risks and ecological scarcities. The green economy adds to sustainability, the accountability of past environmental deterioration, the need to recover natural capital, and the need to produce economic and social benefits. In this perspective, protected areas are an investment for present and future generations. Restoration of deteriorated areas should be seen as an engine of green economy and development. Protected areas contribute to creating favorable ecological conditions that ensure the health and safety of surrounding human settlements amid the risks of climate change. For instance, protected areas throughout the LAC region, both public and private, hold important wild varieties of staple crops that could prove essential in combating the food security threats posed by climate change. These crop wild relatives may contribute beneficial genes to the region's staple crops, providing them with increased tolerance to rising temperature, salinity, and drought, as well as resistance to pests and diseases (Hunter et al. 2012). Protected areas can contribute to vital economic activities and help mitigate climate change local effects. Mainly, the stability of freshwater supply can be linked to forest and watershed conservation in many Andean regions of South America. The whole activity related to protected areas can be attributed to the green economy. Protected areas can impact the formation of an environmental culture around them, attracting investment for eco-related activities within and near such areas. Coupling biodiversity conservation through protected areas with climate change mitigation seems to be the logical solution in Latin America.

4 Latin American and Caribbean Protected Areas

Looking at the percentage of protected terrestrial and marine and coastal surface area throughout the entire LAC region (Table 1), it is apparent that the Caribbean subregion has the greatest relative coverage by far in comparison with Mesoamerica and South America. Nonetheless, the Caribbean region's terrestrial surface area is equivalent to about 1.3% of South America's and 9.5% of Mesoamerica's terrestrial surface area, while the subregion's marine and coastal surface area are equivalent to 27% of South America's and 70% of Mesoamerica's marine and coastal area. Consequently, the Caribbean region is quite successful in protecting its biodiversity and ecosystems, yet it is only a small portion of the entire LAC region. On the other hand, countries like Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, Mexico, and Peru have significant protected area coverage (square kilometers of land and marine areas). But, relative to their total country size, protected areas only cover a fraction of these countries. For instance, while Mexico has the greatest coverage in

Mesoamerica in terms of square kilometers and number of protected areas (Fig. 1), every country in Mesoamerica, excluding El Salvador, protects a greater percentage of their country, although in terms of marine coverage, Mexico is in second place following Panama. In South America, there is a similar trend with countries like Brazil and Colombia, which have the greatest number of protected areas in the entire region by far (Fig. 1). Yet in terms of each country's total terrestrial and marine surface area, the greatest terrestrial protected area coverage occurs in Venezuela and French Guyana, while the greatest marine protected area coverage occurs in Chile, followed by Brazil. As a result, despite the high numbers of protected areas in South America and Mesoamerica and the great amount of protected square kilometers of land and sea, these regions have a significant portion of their total surface area left to be protected, particularly in Mesoamerica. Latin America has large countries compared to other regions of the world and has potential to increase protected area coverage to mitigate climate change and conserve biodiversity.

The Convention on Biological Diversity reported that between 2011 and 2020, the LAC region made significant improvements toward meeting Aichi Biodiversity Target 11, which focuses on increasing and improving protected areas (UNEP-WCMC 2016). Specifically, they state that "the region has developed an extensive protected area network, consisting of state and community and private reserves. This protected area network is also increasing in effectiveness in many countries in the region."

5 Traditional Knowledge, Climate Change, and Protected Areas

Traditional and Local Knowledge (TLK) must play a role in the management of protected areas, mainly when climate change rapidly affects local communities and puts their livelihoods under threat. Local communities have long noticed that their environment is rapidly changing and are aware of climate change. Their historical knowledge of local ecosystems and their cycles and variability make them key agents for ecosystem management. Their accumulated knowledge across generations, as part of collective practices in the environment, provides unique insights into the current challenges regarding biodiversity conservation and ecosystem functioning (Anbleyth-Evans and Lacy 2019; Reyer et al. 2017). Therefore, the role of TLK in biodiversity conservation cannot be underestimated.

Moreover, large spans of native rainforests are owned by traditional local societies. Their fate is closely tied to forest conservation. Current threats like mining, forest burning for livestock rearing and grain production for livestock feed, oil exploration, and road construction are among the main drivers of biodiversity extinction and habitat loss in Latin America. Climate change is increasing ecosystem vulnerability to human actions, and nature under local communities' protection should be seen as a buffer to mitigate the effects of climate change. Examples of this are: oil exploration

Table 1 Latin America and Caribbean protected area data

Country	Terrestrial surface area (km^2)	Marine and coastal area (km^2)	Number of protected areas	Terrestrial protected area coverage (km^2)	Percent terrestrial protected area coverage (%)	Marine protected area coverage (km^2)	Percent marine protected area coverage (%)	Region
Anguilla	86	92,654	7	10	11.14	63	0.07	Caribbean
Antigua and Barbuda	455	108,492	18	96	21.00	325	0.30	Caribbean
Argentina	2,785,328	1,083,151	463	236,109	8.48	127,449	11.77	South America
Aruba	189	25,214	3	36	18.92	0	0.00	Caribbean
Bahamas	13,458	597,705	54	4930	36.63	47,355	7.92	Caribbean
Barbados	444	185,020	9	6	1.27	10	0.01	Caribbean
Belize	22,298	36,250	120	8372	37.55	3994	11.02	Mesoamerica
Bermuda	72	451,644	28	2	2.08	0	0.00	Caribbean
Bolivia	1,089,909	0	167	336,407	30.87	0	0.00	South America
Brazil	8,529,399	3,672,584	3202	2,584,808	30.30	985,042	26.82	South America
The British Virgin Islands	176	80,529	88	16	9.11	3	0.00	Caribbean
Cayman Islands	289	119,605	58	31	10.76	93	0.08	Caribbean
Chile	759,821	3,657,313	222	158,788	20.90	1,511,390	41.33	South America
Colombia	1,145,033	730,742	1341	193,618	16.91	125,437	17.17	South America
Costa Rica	51,636	576,110	165	14,673	28.42	15,721	2.73	Mesoamerica
Cuba	111,643	365,756	230	18,119	16.23	14,090	3.85	Caribbean
Curacao	451	30,535	14	71	15.75	12	0.04	Caribbean
Dominica	766	28,749	9	168	21.96	10	0.03	Caribbean

(continued)

Table 1 (continued)

Country	Terrestrial surface area (km^2)	Marine and coastal area (km^2)	Number of protected areas	Terrestrial protected area coverage (km^2)	Percent terrestrial protected area coverage (%)	Marine protected area coverage (km^2)	Percent marine protected area coverage (%)	Region
Dominican Republic	48,510	270,774	147	12,727	26.24	48,625	17.96	Caribbean
Dutch Caribbean	323	25,112	14	92	28.37	25,112	100.00	Caribbean
Ecuador	258,139	1,079,901	83	59,932	23.22	144,123	13.35	South America
El Salvador	20,573	94,238	202	1778	8.64	666	0.71	Mesoamerica
Falkland Islands	12,401	549,092	33	61	0.49	52	0.01	South America
French Guyana	83,035	136,564	39	43,588	52.49	1365	1.00	South America
Grenada	374	26,282	49	36	9.54	26	0.10	Caribbean
Guadeloupe	1679	91,039	87	1172	69.82	90,959	99.91	Caribbean
Guatemala	109,922	118,336	352	22,116	20.12	954	0.81	Mesoamerica
Guyana	211,200	136,910	5	17,953	8.50	26	0.02	South America
Haiti	27,390	123,867	27	2357	8.61	1826	1.47	Caribbean
Honduras	113,291	219,971	118	26,568	23.45	10,070	4.58	Mesoamerica
Jamaica	11,059	246,488	154	1789	16.18	1860	0.75	Caribbean
Martinique	1150	47,644	73	926	80.53	47,904	100.00	Caribbean
Mexico	1,965,285	3,284,660	1146	284,801	14.49	707,956	21.55	Mesoamerica
Montserrat	101	7628	1	11	11.11	0	0.00	Caribbean
Nicaragua	129,222	223,935	84	27,585	21.35	7597	3.39	Mesoamerica
Panamá	75,498	332,643	114	23,682	31.37	89,297	26.84	Mesoamerica

(continued)

Table 1 (continued)

Country	Terrestrial surface area (km^2)	Marine and coastal area (km^2)	Number of protected areas	Terrestrial protected area coverage (km^2)	Percent terrestrial protected area coverage (%)	Marine protected area coverage (km^2)	Percent marine protected area coverage (%)	Region
Paraguay	401,498	0	98	57,473	14.31	0	0.00	South America
Peru	1,298,537	838,330	264	289,155	22.27	4037	0.48	South America
Puerto Rico	9041	176,163	109	667	7.38	3201	1.82	Caribbean
Saint Barthélemy	25	4318	5	5	20.36	4244	98.29	Caribbean
Sint Maarten	36	498	3	0	0.73	43	8.70	Caribbean
St. Kitts and Nevis	271	10,263	10	62	22.90	408	3.98	Caribbean
St. Lucia	622	15,560	42	117	18.75	34	0.22	Caribbean
St. Martin	60	1069	22	8	12.77	1031	96.43	Caribbean
St. Vincent and the Grenadines	410	36,511	55	92	22.42	80	0.22	Caribbean
Suriname	147,558	128,363	22	21,426	14.52	1981	1.54	South America
Trinidad and Tobago	5213	75,798	44	1595	30.59	37	0.05	Caribbean
Turks and Caicos Islands	1018	154,242	34	452	44.37	150	0.10	Caribbean
U.S. Virgin Islands	376	36,030	46	54	14.37	307	0.85	Caribbean
Uruguay	178,460	130,098	22	6557	3.67	979	0.75	South America
Venezuela	917,368	473,325	290	521,790	56.88	20,590	4.35	South America

Source Data obtained from Protected Planet (protectedplanet.net)

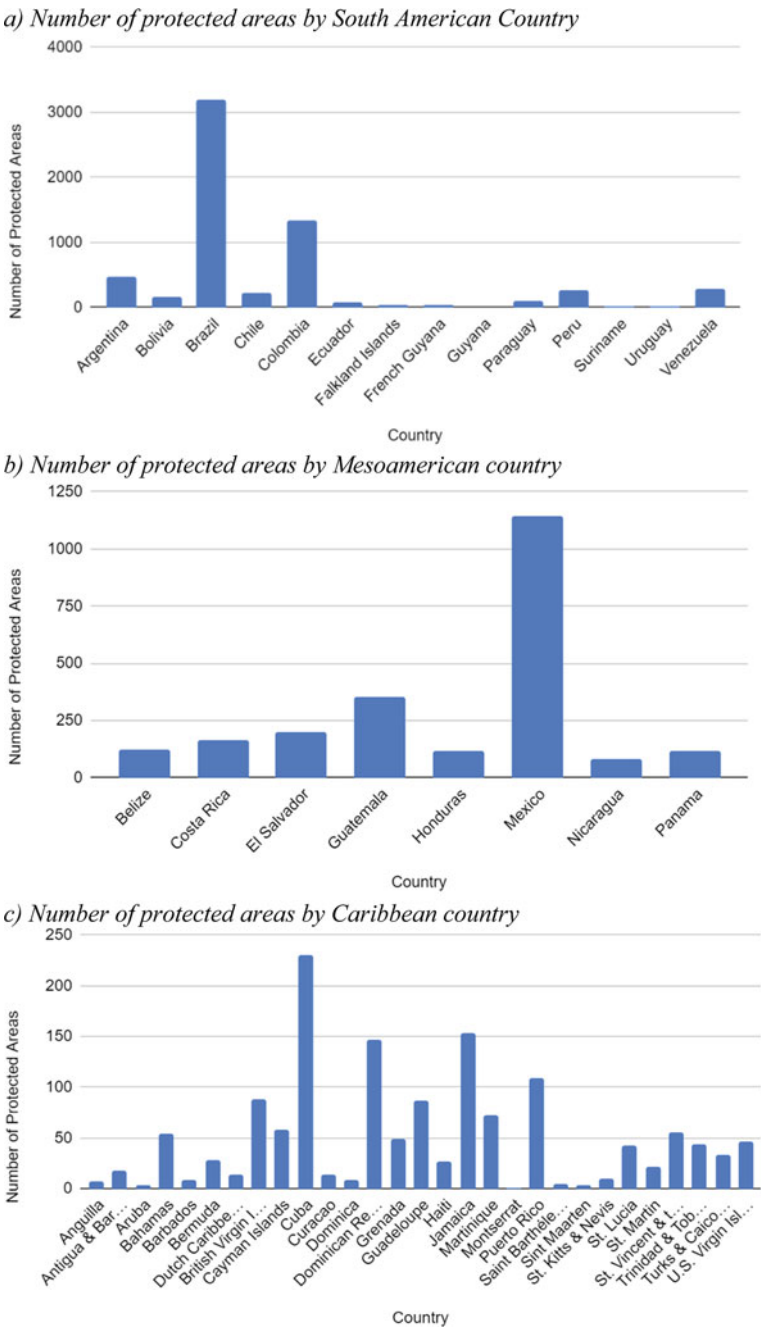

Fig. 1 Number of protected areas (terrestrial and marine) per country in **a** South America, **b** Mesoamerica, and **c** the Caribbean. *Source* Graphs created using data from Protected Planet (protectedplanet.net)

in Ecuador (Finer et al. 2008); slash and burn deforestation in the Cerrado of Brazil for soybean plantations (Pivello 2011); forest burning for livestock production in the Amazon (França et al. 2021); road construction in Choco-Darien between Colombia and Panama (Gómez et al. 2014); tourism development in the Yucatan peninsula mangrove forests (Mexico Daily Post 2021); and habitat replacement for agriculture in El Chaco of Paraguay (Cardozo et al. 2013).

Local people conserving large areas of biologically and culturally rich countries offer accumulated experiences and an opportunity for biodiversity conservation and climate action. LAC represents a unique set of ecosystems where rich biodiversity is spatially correlated with rich cultural diversity. Multiple examples of local indigenous peoples preserving nature are widespread in LAC. For example, the Mosquitia Biosphere reserve in Honduras, the Maya jungle in Guatemala and Mexico, and the rich cultural diversity of the Amazon people.

Latin America was the cradle of three main civilizations that developed agriculture, technologies, and culture intertwined with biodiversity knowledge. Mayan people have inhabited Mesoamerica for the last three thousand years, suggesting that Mayan farmers have successfully adapted to maintain both nature and culture in the long run (Barrera-Bassols and Toledo 2005; Herrera Lima and Gómez 2017). Jaguars, snakes, and other species of animals and plants played a crucial role in their cosmovision. Knowledge of flora and fauna shows a deep understanding of animal-plant relationships and zoological behavior, ethnobotany, and nature's importance for agriculture. Multiple indigenous groups throughout Latin America remain uncontacted by the outside world, living in resource-rich environments that these groups manage. However, attempts by the outside world to make contact with uncontacted tribes to gain access to these resources put these indigenous groups in grave danger, along with the environments they manage and conserve. In 2015, a national park was created on the Peruvian side of the Sierra del Divisor region to protect uncontacted tribes and their unique environment, including rare and endangered animal species. Nonetheless, like many other protected areas throughout the region, the lack of proper park management has meant that illegal loggers and miners, as well as drug traffickers, continue to be present in the area (Survival International 2021).

LAC offers unique opportunities to confront the immediate impact of climate change. Its large size, rich biodiversity, pristine and still well-preserved ecosystems, and the existence of large portions of land owned by local communities should be regarded as an opportunity for effective climate change mitigation. Implementing the proper mechanisms for the conservation of forests and other significant natural ecosystems should be considered a priority for effective climate change prevention and mitigation, carbon sequestration, and ecosystem functioning processes for the benefit of society. It is essential to combine economic and environmental legislation to utilize the vast potential of nature conservation for climate change action and sustainable development as habitat loss and ecological degradation rapidly increase, aggravated by climate change phenomena like extreme episodes of rain, drought, hurricanes, tornadoes, and forest fires. It is urgent to develop a regional strategy that

secures nature, mitigates climate change, and provides ecosystem services for the sustainability of local livelihoods.

6 Concluding Remarks

Two of the most, if not the most, significant environmental issues faced by our world are biodiversity loss and climate change, with extensive scientific evidence indicating that we are currently living through a sixth mass extinction. The LAC region holds about 60% of the planet's terrestrial life forms, and six out of the ten most biodiverse countries in the world are located in the region. Thus, protected areas play a crucial role throughout LAC, serving as an essential tool to combat the effects of climate change and to reduce biodiversity loss. Some of the climate change effects already impacting the region include increased storm events and storm intensity, drought, forest fires, biodiversity loss, threatened water supplies, and threatened food security, among many others. The effects of climate change are expected to accentuate the region's vulnerabilities, making the LAC region particularly susceptible to climate change.

Protected areas mitigate the effects of climate change on biodiversity by providing wildlife with space to adjust to changing climatic conditions. Terrestrial protected areas throughout the LAC region provide important vegetative genetic diversity, which may prove essential in fighting food insecurity caused by climate change. Additionally, these areas store large amounts of carbon, particularly those protecting the Amazon rainforest and temperate forests in the southern part of the region, and serve an essential role in combating deforestation within these crucial ecosystems. For protected areas to effectively fight the effects of climate change in the LAC region, the coverage of terrestrial and marine/coastal protected areas must be extended to cover a more significant proportion of natural ecosystems, particularly areas considered as biodiversity hotspots. Furthermore, increased protected area connectivity is essential for the persistence of biodiversity as climate change shifts the distribution of species. It is also imperative to consider the essential historical knowledge of ecosystems held by local and indigenous communities, whose fate is often linked to the protection of such ecosystems. The incorporation of traditional knowledge is an essential piece to consider in the management of protected areas. Indigenous Peoples and Local Communities should play a role in managing the protected areas created to protect the ecosystems they have long inhabited.

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