

Ecuador's Montane Cloud Forests:

An Examination on Threats to Their Continued Existence

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3/12/2016

Abstract:

Ecuador is a small country located on the Pacific coast of South America. Even though it is small, it contains some of the world most biologically diversity hotspots. One of these areas is the montane cloud forest. Only 2.5 percent of tropical forests actually meet the criteria to be considered cloud forests, and 25 percent of cloud forests in the world are found in the tropical Andes. Many species of epiphytes inhabit this region, as well as hundreds of species of birds, and even the only south American bear species. These forests are facing significant threats leading to their decline. Pollution, tourism, and global climate change all threaten this unique ecosystem. There is hope however to help protect these areas. Education, and sustainable ecotourism meaning putting the preservation of the forest first before making the profits, could be used as powerful tools to protect the region.

Introduction:

Although they comprise only 2.5 percent of tropical forests, montane cloud forests, are some of the most important ecosystems in the world. They provide drinking water for many major Ecuadorian cities, they generate revenue through ecotourism, and they are also located where two of the world biological diversity hotspots, the tropical Andes and the Choco-Darien western Ecuadorian, meet (Sáenz 2013). The tropical Andes alone contain about 16 percent of the world's plant species, and almost 20 percent of the world's bird species. Cloud forests in Ecuador generally occur from altitudes that range from 1800 to 2800 meters, where persistent cloudiness occurs almost daily. There is usually always very high relative humidity in these environments, and this has led to the increased speciation of amphibians, and epiphytes or plants that grow harmlessly on trees and take moisture and nutrients from hanging roots. Even though many of these forests are located in some of the most difficult to access terrain on the planet, their staggering amount of biological diversity draws in many tourists each year. (Intag cloud forest reserve 2016)

Cloud forests have been compared to archipelagos when their high endemism is discussed. These fragmented forests lead to high speciation rates which increase biodiversity, but many of these species cannot survive in any other environments. One of the biggest threats to the cloud forest ecosystem is increased air and water pollution. Air pollution, specifically the increase in atmospheric concentrations of carbon dioxide can lead to acid rain and fog. Amphibians are especially susceptible to this as their permeable skin is open to pollutants in the water around them. Other forms of pollution can also be detrimental, such as heavy metal

pollution in rivers and streams due to mining in some of these cloud forest regions. Another significant threat to the cloud forests is increased tourism. Tourism can lead to the destruction of forested areas in order to increase accommodations, and even eco-tourism has some impact on these areas. However, tourism could also be a way to protect these regions. Finally, global climate change, which threatens the entire planet, has a particularly harsher effect on montane cloud forest environments. This is due to a few main reasons, the first; climate change is likely to lead to a change in weather patterns, specifically the low level cloudiness that envelops these forests. Second, warming global surface temperatures are eventually going to allow for the spread of lower altitude species higher up mountain slopes, pushing cloud forest ecosystems to higher altitudes until there is nowhere left to go. (Roman-Cuesta 2011) Since cloud forest species are highly specialized to survive in these conditions, it is likely that many will not be able to adapt to other environments leading to their extinction. Third, an increase in global sea surface temperatures is likely to result in stronger hurricanes and storms. This is not so much a problem to the Ecuadorian cloud forests, as hurricanes and cyclones cannot form within 5 degrees of the equator due to a lack of Coriolis forces. (Foster 2001)

The importance of cloud forests cannot be overstated. This paper will discuss endemic flora and fauna that call the cloud forest home in order to increase awareness about what kind of diversity will be lost with their destruction. It also will delve deeper into the threats facing the Ecuadorian cloud forests. Finally, things that can be done to preserve and protect the cloud forest will be examined. This involves ecotourism and education, and environmental policies that are intended to mitigate climate change. The goal is to leave off with a sense of cautious

optimism for the future of the cloud forest, even though it faces many potentially catastrophic threats.

Cloud Forest Flora and Fauna:

Some of the most unique and endemic plants of the Ecuadorian cloud forests are epiphytes. One of the most famous epiphytic plants in the world is the orchid. Known for their beautiful and extremely diverse flowers, there are 4000 known species in Ecuador (Ecuador-Travel.net 2015). Many of these species live in the humid cloud forest regions, and some are even endemic to small patches of forest. New orchid species are still being discovered in Ecuador. Orchids are not only stunningly beautiful, but they are the perfect example of niche species, highlighting Darwin's theory of evolution by means of natural selection. Different orchid species have modified flowers that cater to specific pollinators such as hummingbirds, butterflies, and moths. One genus of orchids, the Vanilla orchids, is famous since their pods are what makes vanilla flavoring and extracts. These vanilla orchids are cultivated mostly in Mexico, however they are present throughout the tropics and even in Ecuador's very own cloud forests. Without these humid cloud forest environments orchids could be severely threatened and many endemic species would go extinct. (Nash 2005)

Another family of plants that thrive in the moist cloud forest environments are the bromeliads. The most famous bromeliad is most likely the pineapple, as it is the only species commercially produced for consumption. This plant family is especially diverse, and it thrives in many environments across the Americas. This may actually be one species that can handle climate change globally; however species endemic to the Ecuadorian montane forests and

highlands could disappear. About half of all bromeliads are epiphytes as well, and they provide unique niche habitats for many species in the cloud forest. The basal leaf structure of some species forms a “tank” in which they store water. Many invertebrates use these pools of water to hatch their larvae, and even some amphibians will rear their tadpole young within bromeliads. Bromeliads even create habitats for other smaller, carnivorous bromeliads to live inside of them eating up insects that fall in. In one study done in the lowland region of eastern Ecuador in 2002, researchers collected 209 bromeliads, and found 11219 individuals of 354 morphospecies living in these bromeliads (Armbruster et al 2002). Even though this study was not conducted in Ecuadorian cloud forests, it still illustrates the dramatic amount of biodiversity that each of these single plants harbor. Losing these endemic species of bromeliad in cloud forest regions would likely mean the loss of many other species as well. (Judson 2008)

The cloud forest is not just home to plants, small amphibians, and invertebrates. One species that calls the Ecuadorian cloud forest home is the spectacled bear (*Tremarctos ornatus*), also known as simply, the Andean bear. Being the only bear in South America, it has claimed the title of being the largest carnivore on the continent. Do not let that fool you however, as these bears are extremely timid and mostly eat fruit. In fact they have been observed sitting in trees for days waiting for fruits to ripen. There are only about 3,000 of these bears left in the wild, and they are listed as vulnerable to extinction on the IUCN list. Most of the threats these bears face are directly related to fragmentation of their habitat. They have been seen leaving cloud forest regions in search of food in coastal lowlands and even grassland areas. Sometimes they are killed for their meat and furs, but also by farmers since they can be agricultural pests. (National Geographic 2016)

Another unique animal that is present in the cloud forest environment is the Andean cock-of-the-rock (*Rupicola peruvianus*). This medium sized bird is most well-known for its vibrant plumage and mating display. Mature males have orange colored plumage on the top half of their bodies. They also have a crest of plumage on their heads that is the same color. Since the species exhibits sexual dimorphism, the female is colored a dull brown. Their diets consist of many invertebrates, small reptiles, amphibians, and even mice. These birds are known as cock of the rock due to the fact that they nest in rocky outcroppings of the cloud forest. Currently they are not listed as threatened due to the fact that they inhabit a wide range of habitat. However, they still face the threats caused by habitat fragmentation. The Andean cock of the rock is synonymous with the cloud forests of Ecuador and many tourists travel to this region to see this bird along with the hundreds of other species of birds. (Begazo et al. 2012)

Significant Threats to Ecuadorian Montane Cloud Forests:

Now that some of the important species have been highlighted it is time to discuss the different threats affecting this diverse habitat. Pollution has long been a threat to every type of habitat, however due to the small area that cloud forests can form in, pollution effects can be exacerbated in these environments. Although no studies have been performed to confirm this, it is feasible that air pollution from Ecuador's large coastal cities can be brought up to the cloud forests by the same prevailing winds that bring the much needed moisture for these environments. These pollutants would also likely be deposited in the precipitation on the windward side of the mountains. Increased carbon dioxide in the atmosphere would also lead

to acid precipitation, and since the cloud forest is highly dependent on precipitation for survival, this could lead to significant problems with many of the endemic plants and animals. Other forms of pollution, resulting from mining operations in this region also pose a direct threat to cloud forest ecosystems. Although Ecuador's mining operations are not extensive in these regions yet they could lead to increased habitat fragmentation but also heavy metal contamination in streams and rivers that could potentially bio accumulate in organisms.

Since Ecuador's cloud forests contain such diverse concentrations of wildlife, beautiful landscapes, and many recreational activities such as rafting and zip lining, tourism is a growing industry as well as a threat in this region. If not properly managed, tourism can bring in invasive species, damage habitats, and lead to increased pollution in these ecologically sensitive forests. Although many of Ecuador's cloud forests fall in protected reserves, these areas are not as stringent on regulations as national parks. This means a lot of areas in these reserves are privately owned and also farmed. Trails and private roads throughout the forest can lead to habitat fragmentation, and depending on the amount of tourists using the trails and the time of year, different species may be affected. The increase in tourism also means there must be an increase in infrastructure in these remote areas. That means more power lines must be erected, more water systems put into place, and more roads to be built. Tourists can also contribute to pollution in areas that they visit, as these areas are not their homes leading for them to deposit trash and other solid waste. This should not be a significant problem however since many of the people who come to visit the Ecuadorian cloud forests are environmentally conscious and they are there to enjoy the pristine, unobstructed nature that is still present in these locations. (Sáenz 2013)

By far, the most significant threat to Ecuador's cloud forests is global climate change. Climate models, although they predict higher levels of evaporation leading to more clouds, have hinted that the low level cloudiness associated with cloud forests looks like it will decrease substantially in the coming years. This would put a strain on the species of this water dependent ecosystem. Increased stress on species could make them more susceptible to disease and illness that have always been present in these environments. We see this happen in the pine forests of southern New Jersey. Warmer winters have allowed pine beetles to survive in higher numbers leading to an increase in tree mortality. Similar situations could appear in cloud forest ecosystems especially with amphibians. The chytrid fungus that has been decimating amphibian populations worldwide comes to mind as it could pose a real threat to the endemic amphibians of Ecuador's cloud forests. The fact that these ecosystems are present on the slopes of mountains also means that as global surface temperatures increase, the ecosystems have nowhere to shift but upslope. Cloud forest ecosystems would significantly decrease in area, and areas that are already present on peaks would likely be eliminated as low land vegetation continues to increase its range up mountains. Many species that have become highly specialized in this habitat would likely not survive much of a climate shift, as they are effectively isolated from other suitable habitats just like island chains. Although the exact consequences that will result of a shift in climate are still unclear, the cloud forests of the world are certainly in the most immediate danger as they are very highly dependent on a specific set of weather patterns. (Foster 2001)

Steps to Mitigate Cloud Forest Threats:

Now that the threats to Ecuador's cloud forests have been explained, there has to be something more we can do to protect and preserve these incredible vestiges of biodiversity. In order to do this, regions that exhibit the cloud forest habitat should be protected as national parks, much like the Galapagos Islands. Building is restricted to only 3% of the islands total land area, and it is said that the uninhabited islands are still as pristine as when Darwin set foot on them. Having this approach to the cloud forests would be valuable in protecting them. Also, having national park status would make mining operations even more difficult to conduct in these areas. Any steps that are taken to mitigate climate change globally would also contribute to the long term stability of these sensitive regions. Pledges to reduce carbon emissions to stop the earth warming above 2 degrees Celsius were signed at the COP 21 conference in Paris, France in December of 2015. All of these steps mentioned above do a lot to help preserve Ecuador's cloud forests, but the most effective way to protect these areas at least in the short term is sustainable tourism and education. (Galapagos Conservancy 2016)

Educating local people and people that come to visit these areas from around the world is the key to preserving these habitats. People do not know that these regions are under such grave threats if they do not even know they exist in the first place. Educating people around the world about the magnificent animals and plants that inhabit this place also helps garner support for protection and preservation. This model has worked well in the Galapagos Islands. Through government regulation, eco-tourism in the Galapagos helps sustain the park and in turn helps protect this treasure. The same can be done for the cloud forests. Sustainable tourism, when done right, is a powerful tool in conservation. Zip lining through the canopy of the cloud forest is one of the best ways to get people directly involved with this environment. It

also gives local residents an incentive to protect the environment they call home since it is bringing in much needed revenue. It is important that these places of business are carefully regulated however in order to make sure their impact on the environment remains smaller than if these areas were left unprotected and open to private development.

Conclusion:

Ecuador's cloud forests remain some of the most pristine and biologically diverse regions on this entire planet. The threats these forests face are dire. We can look at these areas as the "canary in the coal mine" so to speak, as they will be affected by global climate changes more quickly and significantly than other environments. The endemic species that call these forests home will also feel the effects of climate change more readily than other species. There is hope for these regions. Through education and sustainable eco-tourism, the cloud forest can be protected. Although it will not be an easy task, these areas still contain many species we have not discovered yet, and provide valuable ecosystem functions for the surrounding areas, which makes them a priority to protect. Look at the Galapagos Islands, if a similar system arises in Ecuador's cloud forests, then there is no doubt that they will fare better against the threats these regions face. Since 25 percent of the world's cloud forests occur in the Andean region, it is important for the people of Ecuador and the other countries to continue to fight for the protection of this national treasure. As an old Greek proverb states "A society grows great when old men plant trees whose shade they know they shall never sit in." It is the duty of the people of the present to preserve the earth for the people of the future, and this holds

especially true for Ecuador's montane cloud forests. It is with cautious optimism that we can begin to view their bright future, if we start protecting them today.

Appendix:

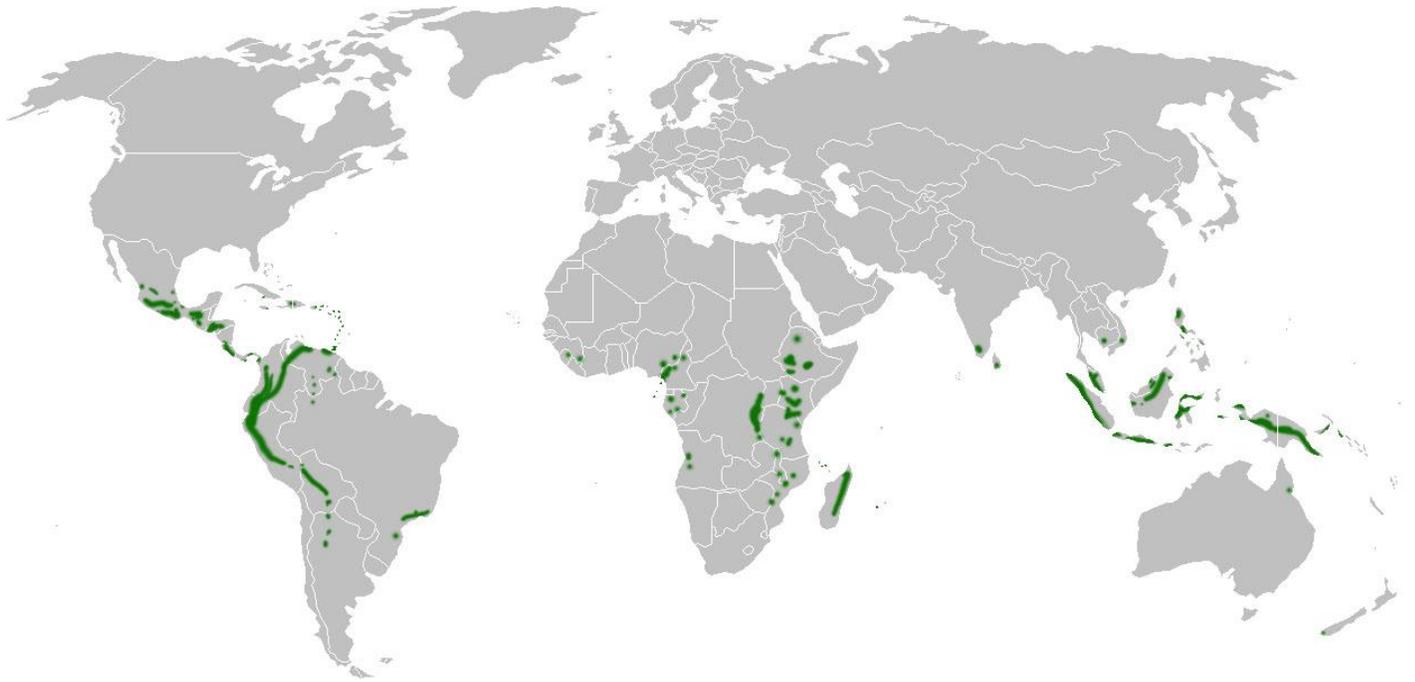


Figure 1 Cloud forest regions of the world Source: Wikimedia commons



Figure 2: Left- Orchid flower Right- Bromeliads Source: Andre Baertschi





Figure 3 Left- Spectacled Bear Right- Male Andean Cock of the Rock Source: Manu road, Peru; 23 July 2009 © Carol Foil

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