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Biodiversity in Latin American countries - status, trends, and relationship to economic growth

Bachelor thesis

Supervisor: Mgr. Zdeněk Opršal, Ph.D.

Olomouc, 2018

I hereby declare in lieu of oath that I wrote this bachelor thesis by myself. All information derived from the work of others has been properly acknowledged in the text and in the list of references.

Olomouc, 2018

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Darya Marusyk

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Zásady pro vypracování:

Bakalářská práce pojednává o problematice ochrany biodiverzity a ekonomického rozvoje ve státech Latinské Ameriky. Součásti práce bude identifikace a posouzení vhodných ukazatelů biodiverzity a její změny dostupných na úrovni států a zhodnocení trendů v oblasti biodiverzity v zemích Latinské Ameriky. Pozornost bude věnována také vztahu mezi ukazateli biodiverzity a ekonomického růstu.

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Abstract

The bachelor thesis focuses on biological diversity of Latin America. Firstly, the author characterizes and compares three biodiversity indexes: Living Planet Index, IUCN Red List Index and Wildlife Picture Index. Then, the author gives information about biodiversity hotspots, total number of known species in Latin America, the overall number of endemic species, the total number of threatened endemic species and changes in the amount of threatened species in each of the selected countries between 2013 and 2017. Selected countries are: Brazil, Colombia, Ecuador, Mexico, Peru, the Bolivarian Republic of Venezuela, Argentina, Bolivia, Panama and Costa Rica. In this thesis are also mentioned factors by which ongoing biodiversity loss and degradation of ecosystems in Latin America are being driven. Attention is also paid to the role of biodiversity in economic growth, to the largest commodity groups for exports, to main economy sectors and their effect on biodiversity. Furthermore, the issue of protected areas is discussed. With the help of literary research and data analysis the author was able to make the conclusion that the region is among the world's richest on biological diversity, that during the last years the number of threatened species has increased, the number of protected areas has also increased, and that the most important sectors of Latin American economies are: fisheries, agriculture, forestry, protected areas and tourism, and they are highly dependent on the region's biodiversity and ecosystems.

Key words: Biodiversity, Latin America, ecosystem, species, threat, sustainable, economic growth, degradation, protected area.

Abstrakt

Bakalářská práce se zaměřuje na biologickou rozmanitost Latinské Ameriky. Za prvé autor charakterizuje a porovnává tři indexy biodiverzity: Living Planet Index, IUCN Red List Index a Wildlife Picture Index. Autor pak poskytuje informace o hotspotech biodiverzity, o celkovém počtu známých druhů v Latinské Americe, o celkovém počtu endemických druhů, o celkovém počtu ohrožených endemických druhů a o změně množství ohrožených druhů v každé vybrané zemi mezi rokem 2013 a 2017. Vybranými zeměmi jsou: Brazílie, Kolumbie, Ekvádor, Mexiko, Peru, Bolívarská republika Venezuela, Argentina, Bolívie, Panama a Kostarika. V této bakalářské práci jsou také zmíněny faktory, které vedou ke ztrátě biologické rozmanitosti a degradaci ekosystémů v Latinské Americe. Pozornost je věnována také roli biodiverzity v ekonomickém růstu, největším komoditním skupinám pro vývoz, hlavním hospodářským odvětvím a jejich vlivu na biologickou rozmanitost. Dále se diskutuje o problematice chráněných oblastí. S pomocí rešerše literatury a analýzy dat byl autor schopen dospět k závěru, že tento region patří mezi nejbohatší na světě v oblasti biologické rozmanitosti, že v posledních letech počet ohrožených druhů vzrostl, počet chráněných oblastí také vzrostl, a že nejdůležitějšími odvětvími latinskoamerických ekonomik jsou: rybolov, zemědělství, lesnictví, chráněné oblasti a cestovní ruch a jsou vysoce závislé na biologické rozmanitosti a ekosystémech regionu.

Klíčová slova: Biodiverzita, Latinská Amerika, ekosystém, druhy, hrozba, udržitelný, ekonomický růst, degradace, chráněné území.

List of Abbreviations

CEPF Critical Ecosystem Partnership Fund

FAO Food and Agriculture Organization of the United Nations

GDP Gross domestic product

IUCN International Union for Conservation of Nature

LAC Latin America and the Caribbean

LPI Living Planet Index

Mha Mega hectare (ha x 10^6)

OECD Organization for Economic Co-operation and Development

RLI Red List Index

SDGs Sustainable Development Goals

UN United Nations

UNEP United Nations Environment Programme

US United States

WCMC World Conservation Monitoring Centre

WPI Wildlife Picture Index

WWF World Wildlife Fund

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Introduction

During my studying in the department of the International Development Studies the issue of biodiversity has excited the curiosity of mine. In addition, Latin American region aroused in me a great concern. The region is considered among the world's richest on biological diversity. Moreover, Latin America is also one of the planet's greatest centers of endemic diversity, which is confronting a great number of pressures.

Everything in our life depends on biodiversity: the water that people drink, the air that people breath and even people's nutrition. However, nowadays, human activities are considered as the main driver that is pushing our planet into a sixth mass extinction. It is important to spread the awareness about biodiversity loss until it is too late.

This thesis provides an overview on current status and trends of Latin America's biodiversity, tells about biodiversity itself, about the causes of its loss and the degradation of the ecosystem services. The thesis also defines the advantages of biological diversity, gives reasons for protecting it and deals with the issue of protected areas in the region. Attention is also paid to the relationship between biodiversity and economic growth of the region. The most important sectors, which are highly dependent on region's biodiversity, of Latin American economies are presented. Furthermore, three biodiversity indexes (Living Planet Index, Red List Index, Wildlife Picture index) are characterized and compared to identify their relevance to Aichi biodiversity targets and Sustainable Development Goals.

Methods and objectives

The purpose of this bachelor thesis is to characterize the state of biodiversity in Latin American countries. Ten countries were chosen for the thesis: Brazil, Colombia, Ecuador, Mexico, Peru, the Bolivarian Republic of Venezuela, Argentina, Bolivia, Panama and Costa Rica. Firstly, six of the world's most biodiverse countries within the region of Latin America (Brazil, Colombia, Ecuador, Mexico, Peru and the Bolivarian Republic of Venezuela) were considered. Then, other four countries ware added. Argentina and Bolivia, which are included in "the eight Latin America and Caribbean countries with the greatest diversity of mammalian species" and also Panama and Costa Rica, because they are included in "the nine Latin American and Caribbean countries with the greatest diversity of amphibian species"(UNEP, 2010a).
In order to achieve the aim of this bachelor thesis, the author should answer the following research questions:

- What is biological diversity?
    - Are there any levels of biodiversity?
    - What are the main causes of biodiversity loss?
    - Are there any reasons for protecting it?
- What are the trends in the abundance of species in Latin America?
    - How many species are found in the region?
    - How many of them are endemic?
    - How many species are threatened?
- What are the most important sectors of Latin American economies?
    - How biodiversity impacts these sectors?
    - How these sectors affect biodiversity?
- What are the main trends concerning the Aichi Target 11 in the region?
    - How changed the coverage of the protected areas over the last few years within the region?
    - How many protected areas are in the selected countries?
        - ◊ Are they efficient?

In order to answer these questions, the author is making literary research and data analysis. The main reports used are: *Global Environment Outlook: Latin America And The Caribbean* (UNEP), *Importance Of Biodiversity And Ecosystems In Economic Growth And Equity In Latin America And The Caribbean: An Economic Valuation Of Ecosystems* (UNDP); *The State Of Biodiversity In Latin America And The Caribbean: A Mid-Term Review Of Progress Towards The Aichi Biodiversity Targets* (UNEP-WCMC) and *Living Planet Report* (WWF). Moreover, 1992 Convention On Biological Diversity was one of the major sources for definitions used in thesis. World Bank's portal, The IUCN Red List of Threatened Species database, United Nations 2016 International Trade Statistics Yearbook, United Nations Comtrade database and UNEP are the main sources for the charts and maps used in the thesis.
This thesis has four main chapters. The first chapter deals with the selection of the suitable indicator of biodiversity. Three indexes were compared. Specifically, Living Planet Index, IUCN Red List Index and Wildlife Picture Index. The IUCN Red List Index was chosen. Firstly, because of the better availability of resources. Secondly, because this index includes species from a broad range of taxonomic groups (vertebrates, invertebrates, plants and fungi). Finally, I consider that it is the most suitable indicator helping to monitor whether the Aichi biodiversity targets and Sustainable Development Goals are being met.
The second chapter is telling about biological diversity itself. Then, characterizes trends and major threats in the biodiversity of Latin America. The information about the total number of

threatened species in each of the selected countries between the years 2013 and 2017 is given. Furthermore, the overall number of endemic species and the total number of threatened endemic species in each of the selected countries in the year 2017 is also presented in the chapter. Moreover, a brief overview of the region's biodiversity hotspots is provided.
The next chapter is about the major sectors of the Latin American economies and about their contribution to GDP. Here is also described the impact of the economic activities on biodiversity and the influence of biodiversity and ecosystem services on the sectors. The chapter also provides reader with an overview of the largest commodity groups for exports.
The last chapter is devoted to the issue of protected areas in the region. The reader will be introduced with two definitions of the protected areas and with their importance to the region. Furthermore, the information about the changes in coverage of protected areas between 1990 and 2016 is included.

1. Biodiversity indicators

Biodiversity is so many-sided, that a variety of indicators needed to understand region's status and trends. The aim of this chapter is not only to characterize and compare three biodiversity indexes, which are Living Planet Index, IUCN Red List Index and Wildlife Picture index, but also to identify their relevance to Aichi biodiversity targets and Sustainable Development Goals (SDGs). First of all, I want to write briefly about SDGs and Aichi biodiversity targets.

1.1. International Environmental and Development Goals and Targets

The SDGs, also known as Global Goals, were adopted by world leaders in September 2015 and officially came into force on 1 January 2016. It is a set of 17 goals aimed at ending all forms of poverty, ensuring well-being and prosperity for all the people and protecting the planet's environment at the same time. Each goal has certain targets to be achieved over the next 15 years (UN, 2017c). Among all 17 Sustainable Development Goals two goals are relevant to biodiversity indicators. Specifically, Goal 14, which is to "*conserve and sustainably use the oceans, seas and marine resources for sustainable development"* and also Goal 15, which is to "*protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss"* (UN, 2017c: 10).
The Strategic Plan for Biodiversity includes a set of 20 ambitious and measurable targets, together known as the Aichi Biodiversity Targets, which should be met by the year 2020. The main goals are *"to address the underlying causes of biodiversity loss; to reduce the direct pressures on biodiversity and promote sustainable use; to improve the status of biodiversity by safeguarding ecosystems, species and genetic diversity; to enhance the benefits to all from biodiversity and ecosystem services and to enhance implementation through participatory planning, knowledge management and capacity building"* (Secretariat of the Convention on Biological Diversity, undated: 2). In other words, it is a ten-year plan aimed to achieve sustainability and resilience of biodiversity, for all the countries. The Aichi Targets also address aspects of sustainable development, as they are encouraging sustainable use and providing advantages to all from the use of biodiversity and ecosystem services (IUCN, undated). The SDGs and the Strategic Plan complement and reinforce each other. Consequently, the realization of one contributes to the achievement of the other (Convention on Biological Diversity, undated).

1.2. Aichi Biodiversity Targets, which are related to Red List Index, Living Planet Index and Wildlife Picture Index

The most important and primary related target to all indexes is Aichi **Target 12**, which states that "*by 2020 the extinction of known threatened species has been prevented and their conservation status, particularly of those most in decline, has been improved and sustained"*. **Target 4** tells that "*by 2020, at the latest, Governments, business and stakeholders at all levels have taken steps to achieve or have implemented plans for sustainable production and consumption and have kept the impacts of use of natural resources well within safe ecological limits"*. Aichi **Target 5** specifies that *"by 2020, the rate of loss of all natural habitats, including forests, is at least halved and where feasible brought close to zero, and degradation and fragmentation is significantly reduced"*. Then, Aichi **Target 6**, which points out that "*by 2020 all fish and invertebrate stocks and aquatic plants are managed and harvested sustainably, legally and applying ecosystem based approaches, so that overfishing is avoided, recovery plans and measures are in place for all depleted species, fisheries have no significant adverse impacts on threatened species and vulnerable ecosystems and the impacts of fisheries on stocks, species and ecosystems are within safe ecological limits*". **Target 7** tells that "*by 2020 areas under agriculture, aquaculture and forestry are managed sustainably, ensuring conservation of biodiversity*". Also, **Target 8**, which states that "*by 2020, pollution, including from excess nutrients, has been brought to levels that are not detrimental to ecosystem function and biodiversity*". **Target 9** points out that "*by 2020, invasive alien species and pathways are identified and prioritized, priority species are controlled or eradicated, and measures are in place to manage pathways to prevent their introduction and establishment*". Then **Target 10** indicates that "*by 2015, the multiple anthropogenic pressures on coral reefs, and other vulnerable ecosystems impacted by climate change or ocean acidification are minimized, so as to maintain their integrity and functioning*". **Target 11** tells that "*by 2020, at least 17 per cent of terrestrial and inland water, and 10 per cent of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services, are conserved through effectively and equitably managed, ecologically representative and well connected systems of protected areas and other effective area-based conservation measures, and integrated into the wider landscape and seascapes*". **Target 14** points out that "*by 2020, ecosystems that provide essential services, including services related to water, and contribute to health, livelihoods and well-being, are restored and safeguarded, taking into account the needs of women, indigenous and local communities, and the poor and vulnerable*". Finally, **Target 15**, which tells that "*by 2020, ecosystem resilience and the contribution of biodiversity to carbon stocks has been enhanced, through conservation and restoration, including restoration of at least 15 per cent of degraded ecosystems, thereby contributing to climate change mitigation and adaptation and to combating desertification*" (UNEP-WCMC, 2016a: 41-93).

1.3. Living Planet Index

As stated by McRae et al. (2008: 3), the Living Planet Index (LPI) as „*an indicator of change in global biodiversity based on change in population abundance of vertebrate species from all around the world*". According to WWF (2016b) the LPI is monitoring three systems: terrestrial, freshwater and marine system. The terrestrial system is the best monitored of the three systems. The reason for that is because this is where people live and also because research in this system presents fewer logistical challenges than research in freshwater and marine systems.

LPI also provides information about the most common threats to declining populations of terrestrial, freshwater and marine systems. The LPI database contains threat information for 31% of its declining freshwater populations, 29% of its declining marine populations and 33% of its declining terrestrial populations. McRae et al. (2008: 5) affirm that "*the LPI method uses and is constrained by data that are available and so interpretation of an index at a national scale must take into account potential biases towards well-known taxonomic groups and well-studied locations*".

1.4. Red List Index

According to Bubb et al. (2009: 3) "*the IUCN Red List Index (RLI), which is based on the IUCN Red List of Threatened Species, measures trends in the overall extinction risk ('conservation status') of sets of species, as an indicator of trends in the status of biodiversity*". The RLI is based on IUCN Red List evaluations which uses quantitative criteria based on population size, rate of decline, and area of distribution to assign species to one of seven categories of relative extinction risk (Extinct, Critically Endangered, Endangered, Vulnerable, Near Threatened, Least Concern or Data Deficient) (Bubb et al., 2009).
In 2008, the IUCN Red List included assessments for 44838 species, spanning every country of the world, of which 16928 species were threatened with extinction. This includes species from a broad range of taxonomic groups spanning vertebrates, invertebrates, plants and fungi (Dudley, 2008). At present, it is possible to calculate a RLI for several groups in which all species have been assessed for the IUCN Red List: birds (9956 species, 12% of them are threatened), mammals (5416 species, 23% threatened), amphibians (6119 species, 31% threatened), corals (845 species, 33% threatened) and gymnosperms (980 species, 35% threatened) (Bubb et al., 2009). According to The IUCN Red List of Threatened Species (2012a), all taxa listed as Critically Endangered (CR), Vulnerable (VU) or Endangered (EN) are described as 'threatened' as they are considered to be facing a high risk of extinction in the wild. Butchart et al. (2006) affirm that the key strength of the RLI is its geographic representativeness, being based on information for nearly all species in a taxonomic group (worldwide or at the relevant sub-global scale) and Rodrigues et al. (2006) claim that the Red List, in conjunction with the comprehensive information compiled to support it, has become an increasingly powerful tool for conservation planning, management, monitoring and decision making.

1.5. Wildlife Picture Index

According to O'Brien and Kinnaird (2013: 46-47) "*Wildlife Picture Index is an indicator based on detection-nondetection data for mammals and birds provided by camera trap surveys. The WPI is based on the collection of primary data in a statistically rigorous manner designed to meet the needs of a composite biodiversity indicator*".
The WPI is appropriate for monitoring the component of biodiversity represented by medium-to large-sized terrestrial forest and savannah/grassland mammals and birds (O'Brien, 2010). Also O'Brien and Kinnaird (2013) claim that camera traps have some features that make them useful as a data collection tool. First, they are passive data collection tools which use a silent electronic shutter and an infrared flash and do not distract and scare away animals. Second, camera traps are able to function under different weather conditions and designed for allocation in extreme habitats.

Table 1: Relevance of the indexes to Sustainable Development Goals

SDGs	LPI	RLI	WPI
Goal 14	✓	✓	✗
Goal 15	✓	✓	✓

Source: Prepared by the author.

Table 2: Relevance of the indexes to Aichi biodiversity targets

Aichi Biodiversity Targets	LPI	RLI	WPI
Target 4	✗	✓	✓
Target 5	✓	✓	✓
Target 6	✓	✓	✗
Target 7	✗	✓	✓
Target 8	✗	✓	✗
Target 9	✗	✓	✗
Target 10	✗	✓	✓
Target 11	✗	✓	✓
Target 12	✓	✓	✓
Target 14	✗	✓	✗
Target 15	✗	✗	✓

Source: Prepared by the author.

1.6. Conclusion

Taking into account the above, Living Planet Index, Red List Index and Wildlife Picture Index are three suitable indicators which are helping to monitor whether the Aichi biodiversity targets and Sustainable Development Goals are being met. As shown above, the LPI is an indicator which monitors trends in population abundance of vertebrate species whereas the RLI differs by measuring trends in the overall extinction risk and WPI is based on the collection data for mammals and birds provided by camera trap surveys. Moreover, in contradiction to LPI, which is monitoring mostly vertebrate species, RLI includes species from a broad range of taxonomic groups spanning vertebrates, invertebrates, plants and fungi. Furthermore, the LPI is monitoring terrestrial, freshwater and marine systems and also provides information about the most common threats to declining populations of those systems, unlike WPI, which is monitoring the component of biodiversity represented by medium- to large-sized terrestrial forest and savannah/grassland mammals and birds.
All things considered, the most suitable index for my work would be Red List Index. Firstly, because of the better availability of resources. Secondly, because this index includes species from a broad range of taxonomic groups (vertebrates, invertebrates, plants and fungi).

2. The state of biodiversity in Latin America

2.1. Biological diversity

Over the last few years biodiversity has become a topic of major concern all over the world. But what does exactly this term mean? What are the main factors of decreasing biological diversity? Why should society protect it? The United Nations Convention on Biological Diversity (UN, 1992: 3*)* defines biological diversity as *"the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part: this includes diversity within species, between species and of ecosystems"*. Ecological Society of America (1997) distinguishes three levels of biological diversity:

1. Genetic diversity – is all the various genes, which are contained in all individual species;
2. Species diversity – is all the differences within and between populations of species, and at the same time between various species;
3. Ecosystem diversity – is all the ranges of different environments, biological communities, and ecological processes, as well as variation within individual ecosystems. According to UN (1992a: 3), "*ecosystem means a dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit*".

Nowadays there are lot of problems concerning biodiversity that people need to address before it is too late. Ricketts and Imhoff (2003) in their study affirm that human activities have influence on ecosystems in neighboring and even distant ecoregions, which means that different actions (positive or negative) in one part of the world will affect biodiversity not only in that specific region but also in another. They are also identifying two of the most important threats to biodiversity worldwide:

- urbanization;
- agriculture.

Millennium Ecosystem Assessment (2005) approves that over the last century many people have benefited from the exploitation of biodiversity which have led to biodiversity loss and degradation of many ecosystem services and points out the next causes of biodiversity loss:

- transformation of the natural environment;
- overexploitation;
- climate change;
- spread of invasive alien species;
- pollution;

With the loss of ecosystems, essential ecosystem services they provide are also lost. Ecosystem services for e.g. are: water, climate and air quality regulation, pollination, photosynthesis, soil formation, nutrient cycling, food, raw materials, medicinal resources, fresh water and even mental and physical health (WWF, 2016b). Due to the climate change, which is the most critical threat nowadays, as biodiversity is strongly affected by it, the risk of vanishing for many species

is growing because not all species will be able to migrate or to adapt to new conditions. Changes in the natural environment can be caused by activities like industry, forestry, mining, transportation, sediment and groundwater extraction as well as physical modification of rivers or converting lands for agricultural purposes. The next major threat is spread of invasive species, which invade or are introduced to region where they do not naturally occur (Groom, 2005). It can be also the result of the increasing trade and tourism (Millennium Ecosystem Assessment, 2005). Invasive species can be in form of predator for native species or in form of a disease that was non-native and unusual for the environment (WWF, 2016b). Overexploitation is caused by human activities like unsustainable harvesting, over-hunting or overfishing which leads to serious threats to biodiversity. Pollution makes the environment unsuitable for its normal functioning. Different types of waste and toxic compounds pollute the air, water (for e.g. plastics in the ocean or oil spills) and soil and thus negatively affect natural environment.

Marco Lambertini (WWF, 2016b: 6), general director of WWF International, emphasizes that *"for decades scientists have been warning that human actions are pushing life on our shared planet toward a sixth mass extinction. Wildlife populations have already shown a concerning decline, on average by 58 per cent since 1970 and are likely to reach 67 per cent by the end of the decade*". Hence, this rapid decline of animal and plant species abundance can start to threaten people as planet's natural resources are becoming exhausted. Moreover, Jianming (1987) claims that the extinction of one species may not only damage the entire ecosystem, but also disorder the ecological balance and destabilize the environment. Marco Lambertini (WWF, 2016b: 6) also states that "*we entirely depend on nature, for the quality of the air we breathe, water we drink, climate stability, the food and materials we use and the economy we rely on, and not least, for our health, inspiration and happiness"*. Nováček (2011:115-116) points out three basic reasons for protecting biological diversity:

1. **Ethical reasons** - we should not destroy what we have not created, otherwise we will make a negative impact on the process of evolution.
2. **Ecological reasons** - in order to support life on our planet people should maintain ecological balance and functioning ecosystems, as they provide natural resources without which life on our planet would be impossible.
3. **Economic reasons** - biological resources are essential for human health and well-being, they provide us with food, raw materials (i.e. fur, leather, paper, oil, resin, fibers, cotton, wool) and medicines. In this regard Jianming (1987) states, taht more than 40% of the medicines prescribed in the USA contain natural biological substances and 25 % contain extracts from plants. Furthermore, Chinese medicines, including herbal medicines are mostly produced from wild-animal extracts or plants. He adds (Jianming, 1987: 262) that *"80 % of the food consumed by humans is derived from 20 kinds of different plants and animals"*.

2.2. The richness of species in Latin America

The aim of this chapter is to take a deeper look at biodiversity of Latin America, to characterize its trends and to define it major threats. This chapter also provides a brief overview of the region's biodiversity hotspots. According to UNEP-WCMC (2016a), biomes of Latin America region expand from wetlands and coastal ecosystems to deserts, tropical forests, extensive savannah grasslands and high altitude Andean habitats. Latin American countries are considered among the world's richest on biological diversity, which account for 60 to 70% of

all known life on Earth (UNEP, 2016b). The region is also one of the planet's greatest centers of endemic diversity with six out of world's 35 biodiversity hotspots which are: The Tropical Andes, The Tumbes-Chocó-Magdalena Hotspot, The Cerrado Hotspot, The Atlantic Forest Hotspot and Mesoamerica Hotspot. Moreover, there are six of the world's megadiverse countries within the region - Brazil, Mexico, Colombia, Ecuador, Venezuela and Peru. South America has more than 40% of the Earth's biodiversity, more than 25% of its forests and is the single most biologically diverse area in the world and Central America, with only 0.5% of the world's land mass, has 10% of all of its biodiversity (Bovarnick et al., 2010). The table 3 below shows that LAC (Latin America and the Caribbean) region is home for 31% of all known fish in the world, 30% of mammals, 50% of amphibians, 35% of reptiles and 41% of all known birds. Furthermore, Brazil has the richest avifauna along with Colombia and Peru (Piacentini et al., 2015).

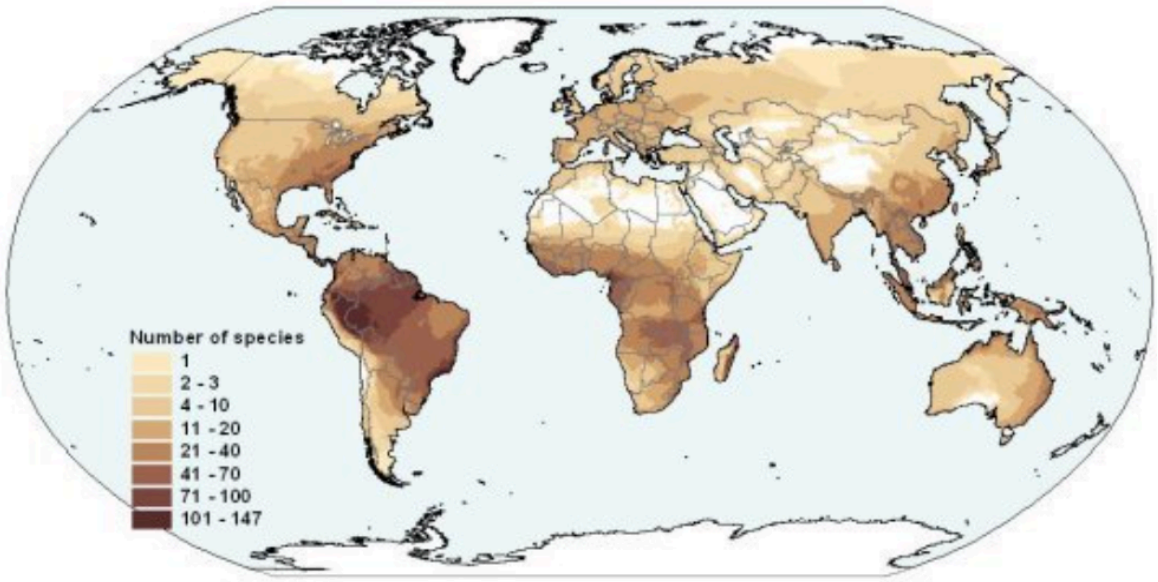
Table 3: Total number of known species in Latin America and the Caribbean as a percentage of total known species

	Total known species	Species in LAC	% of World Total
Birds	9990	4110	41,14%
Mammals	5847	1791	30,63%
Amphibians	6347	3148	49,59%
Reptiles	8734	3060	35,03%
Fish	30700	9597	31,26%

Source: Modified from UNEP, 2010a.

According to the Figure 1, which shows global amphibian diversity, Latin America represents the greatest density of amphibian species on Earth. Furthermore, Brazil has the greatest number of amphibians in the world, with at least 798 species, followed by Colombia with 714 species, Ecuador (467 species), Peru (461 species) and Mexico (364 species) (IUCN, 2017c).

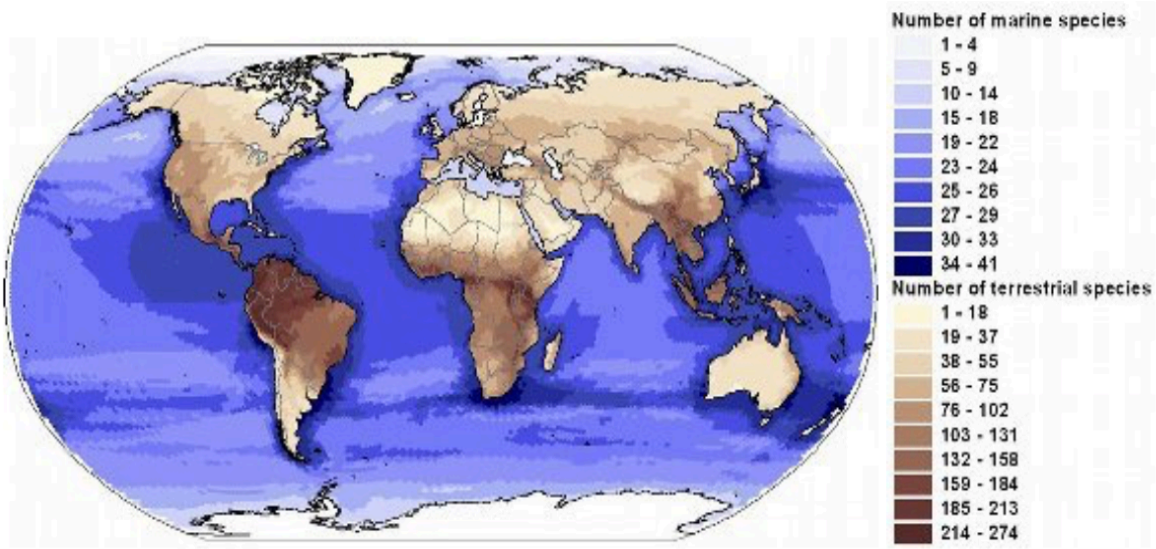
Figure 1: Global diversity of amphibian species



Source: IUCN, 2017c.

The Figure 2 shows global diversity of terrestrial and marine mammal species. Latin America is among the regions with the highest diversity of terrestrial mammal species while marine species are found everywhere in the oceans with maximums along all continental shorelines, alongside with great abundance in the Caribbean Sea and the Pacific Ocean around Central America. In Latin America there are eight of the top 20 countries with the highest diversity of mammal species which are: Brazil, Mexico, Peru, Colombia, Argentina, Ecuador, Bolivia and Venezuela (IUCN, 2017d).

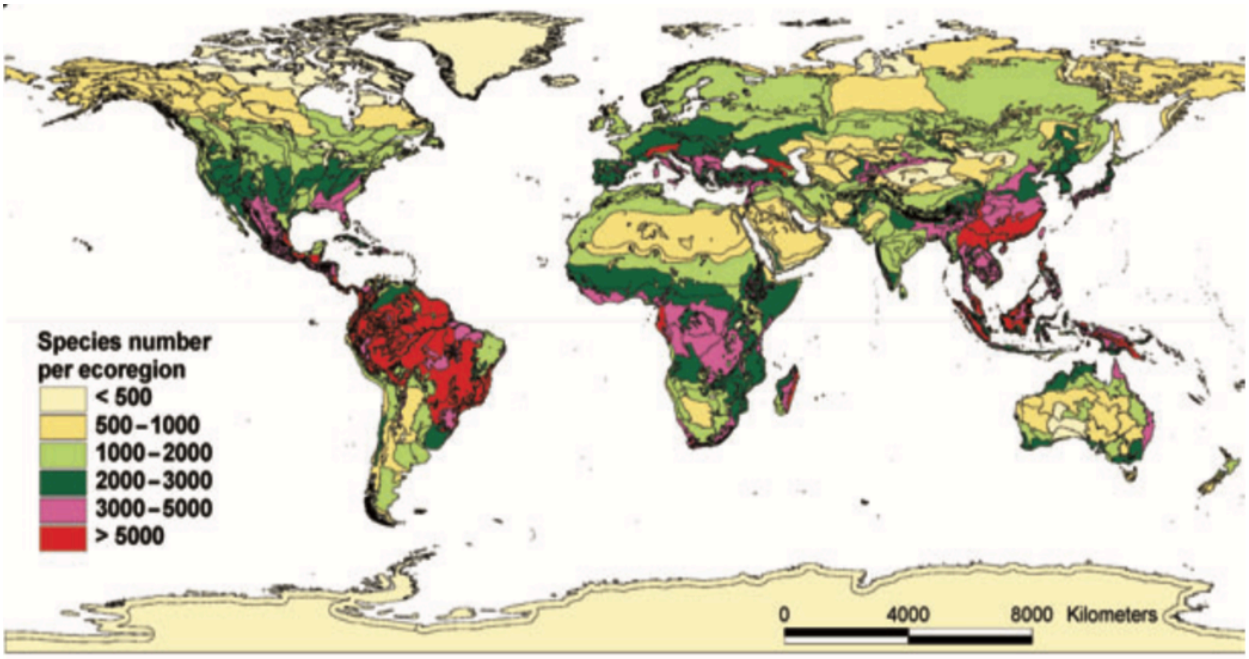
Figure 2: Global diversity of mammal species



Source: IUCN, 2017d.

The following Figure 3 shows the estimated richness of vascular plant species per ecoregion. According to Kier et al. (2005). Latin America is considered to be the second most diverse region on Earth in plant diversity. Among the 51 ecoregions with more than 5000 plant species, 33 are in LAC (UNEP, 2010a). Moreover, there are nine ecoregions with more than 8000 species each in Central and South America. In addition, despite the fact that the southern section of the Amazon basin and northern Colombia are among the areas with very poor underlying data, they are considered to be the most species-rich of all data gaps (Kier et al., 2005). It can be seen from the map that the greatest plant diversity in Latin America can be found in Brazil, Peru, Ecuador, Colombia, Venezuela and Mexico.

Figure 3: Global plant diversity



Source: Kier et al., 2005.

Finally, the tropical South America sub-region consisting of Colombia, French Guiana, Suriname, Guyana, Venezuela, Ecuador, Peru, Bolivia, Paraguay and Brazil, represents the most sizable concentration of tropical rainforest in the world (FAO, 2000). The main distinguishing feature is that tropical forests are often called the "lungs of the planet", as they are producing oxygen and absorbing carbon dioxide. Taking everything above into account, Latin America is definitely one of the most biodiverse regions in the world, with over 40% of the Earth's biodiversity, six biodiversity hotspots, the greatest density of amphibian species, significant amount of mammal species and with a remarkable variety of plant species. However, the region faces number of issues such as habitat loss, forest loss, declines in species abundance and extinction of species, climate change, air, water and soil pollution, rapid economic growth and social inequities, agricultural expansion and high rates of urbanization (UNEP-WCMC, 2016a).

2.3. Biodiversity hotspots and species endemism

According to Myers (1988), biodiversity hotspots are areas which are characterized by outstanding concentrations of endemic species (species that are found nowhere else on Earth and which are facing high rates of habitat loss). In accordance with WWF Glossary (2017a), endemic means *"restricted to a particular area: used to describe a species or organism that is confined to a particular geographical region, for example, an island or river basin"*. In Latin America species endemism is remarkably high. According to UNEP (2010a) estimations, over 25% of all known species of birds are endemic to the region. Moreover, approximately 39% of mammal species, 45% of reptile species, 70% of amphibian species and around 40% of higher plant species are also endemic to the region.

Figure 4: Biodiversity hotspots in Latin America and the Caribbean

Source: UNEP, 2010a.

The Tropical Andes Hotspot is one of 35 global biodiversity hotspots and is considered to be the richest and most diverse region on Earth. The Tropical Andes Hotspot consists of Andes Mountains of Venezuela, Colombia, Ecuador, Peru, Bolivia and the northern parts of Argentina and Chile. At the present time the Tropical Andes Hotspot is the most diverse hotspot, which has the largest number of species and endemic species on our planet. It is also considered as a world leader in plant endemism with approximately 50% of those species found nowhere else on Earth. Moreover, the Andes is the most diverse region in the world for amphibians, as it has approximately 980 amphibian species and more than 670 endemics. Also, there are more than 600 reptile species found, more than 270 of which are endemic. In spite of its abundant biodiversity, it is also one of the most endangered areas in the tropics, because most of its landscape is being transformed due to high levels of urbanization and agricultural activities like

mechanized crop production and extensive cattle ranching (CEPF, 2015a). Some other threats to the region are dams and water management, mining and unsustainable use of biological resources, such as fisheries and logging (IUCN, 2018). As a result of all these pressures, a large portion of the natural vegetation of the Tropical Andes Hotspot has already been lost. It is estimated that the percentage of pristine area is no more than 25% and in all probability, much less (Rodríguez-Mahecha et al., 2004).

The Tumbes-Chocó-Magdalena Hotspot, which extends for 1500 kilometers, is located in the eastern Panama, western Colombia, west coast of Ecuador, northwestern Peru and in the Pacific Ocean on the west from Ecuador. Moreover, the Galápagos Islands and the island of Malpelo are also the part of the hotspot. The concentration of a large variety of ecosystems in a relatively small area is the main reason for high levels of endemism. The Tumbes-Chocó-Magdalena hotspot contains approximately 11000 vascular plant species, 2750 of which are found nowhere else on Earth; 900 bird species, 110 of which are endemic; over 285 mammal species with 11 endemics; more than 320 reptile species, 100 of which are endemic and 200 amphibian species, 30 of which are found nowhere else in the world (Conservation International, 2007b). The degree of threat varies from area to area within the Tumbes-Chocó-Magdalena as the hotspot is threatened by different human activities. Deforestation is among the major threats for the region. Clearing off the native forests for cattle ranching, road construction or agricultural purposes such as unsustainable production of bananas, cocoa and coffee, among other crops. Moreover, unsustainable or illegal timber extraction is common. The other threats are: illegal crops (such as coca and opium poppy), fishing and shrimp farming, mining, population growth, and social conflicts (CEPF, 2005f).

The Cerrado Hotspot is the greatest tropical savanna region in South America, which covers more than 20% of Brazil. The Cerrado has a lot of endemic species, which are endemic not only to the hotspot but also to single sites within it. That is why this region is considered to be one of the biological richest tropical savanna regions in the world. It consists of a large part of Central Brazil, northeastern Paraguay and eastern Bolivia. The region is immensely rich in species, as it contains around 12000 cataloged native species, 250 mammalian species, 262 reptile species and 204 amphibian species. The Cerrado is also one of the most threatened and excessively exploited regions in the world (WWF, 2016b). A lot of unique plants and animals are threatened, among of them is also jaguar, maned wolf and giant anteater. The study of Françoso et al. (2015) reveals the fact that a very small amount of Cerrado's surface is protected (although the Cerrado accounts for 30% of Brazilian biodiversity). Nowadays, its native habitats and abundant biodiversity are being ruined much faster than the Atlantic rainforest. WWF (2016b) points out the major threats for the Cerrado, which are burning of vegetation for charcoal and unsustainable agricultural activities, especially soy production and cattle ranching. For the last 50 years, biodiversity of the Cerrado region is being threatened by clearing of land for pastures and monoculture cultivation. The process of agricultural expansion now extends from Brazil into Paraguay as well *(*CEPF, 2017b). It was also estimated that ongoing uncontrolled occupation of the Cerrado may lead to loss of 72% of its original area by 2020 and of 82% by 2050 *(*CEPF, 2017b).

The Atlantic Forest Hotspot, which is situated in Brazil, Paraguay and Argentina, supports one of the highest degrees of species wealth and rates of endemism on the planet (Ribeiro et al., 2009) and represents more than half of the animals and plants threatened with extinction in Brazil. The Atlantic Forest also has high levels of endemism, as it contains approximately 250 species of mammals (55 endemic), 340 amphibians (90 endemic), 1023 birds (188 endemic), for about 20000 trees (10000 endemic) and more than two-thirds of the primates' species are

also endemic. The main threats to the Atlantic Forest are logging, poaching, animal trading and deforestation, which is caused by agricultural activities and expansion of pasture land and high rate of urbanization, as the significant share of the population lives in this region (*CEPF, 2001c*). In accordance with Conservation International (2011a) the Atlantic Forest has already been reduced to less than 16% of its original forest cover. More than 60% of the animals and the vast majority of the plants facing extinction in Brazil live in this threatened area.

The Mesoamerica Hotspot, which also has high rates of endemism, covers all of the Central American countries (Belize, Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua, Panama and the five states of southeastern Mexico). The region is among the most biologically diverse on the planet with an estimated 24000 species of vascular plants, of which nearly 5000 are endemic, 521 mammal species with 210 endemics and 1193 bird species with 251 of them endemic. Mesoamerica ranks number one for reptiles, and number two for amphibians, birds, mammals and non-fish vertebrates. However, there are a lot of threats to biodiversity in the region:

- poverty;
- ineffective laws and institutions;
- deforestation;
- natural disasters.

Harvey et al. (2008) approve that nearly 80% of the region's vegetation has been transformed to agriculture and that more than 300 of the region's endemic species of flora and fauna are threatened. The main reason for that is that the poor have insufficient access to education, healthcare and assets. Therefore, the majority is working in agriculture, as they have few economic options outside of that sphere. A great deal of those agricultural areas are considered to have very high biodiversity. Moreover, many soils have lost productivity very fast and for this reason, farmers are forced to move to more fertile lands, those that are forested and even protected. Illegal hunting, timber and wildlife harvesting within protected areas and trafficking of fauna continues in spite of different laws and regulations. Deforestation is considered to be the next significant problem in the region, as a territory that was previously completely covered with forest, today is less than half of its original coverage. It is estimated that almost 45 hectares of forest are lost every hour, which is approximately 400000 hectares each year. All of the above affects biological diversity in a negative way (CEPF 2001d; CEPF 2004e). With continuing habitat loss and fragmentation of remaining forests, pressure on the region's biodiversity will intensify (Harvey et al., 2008).

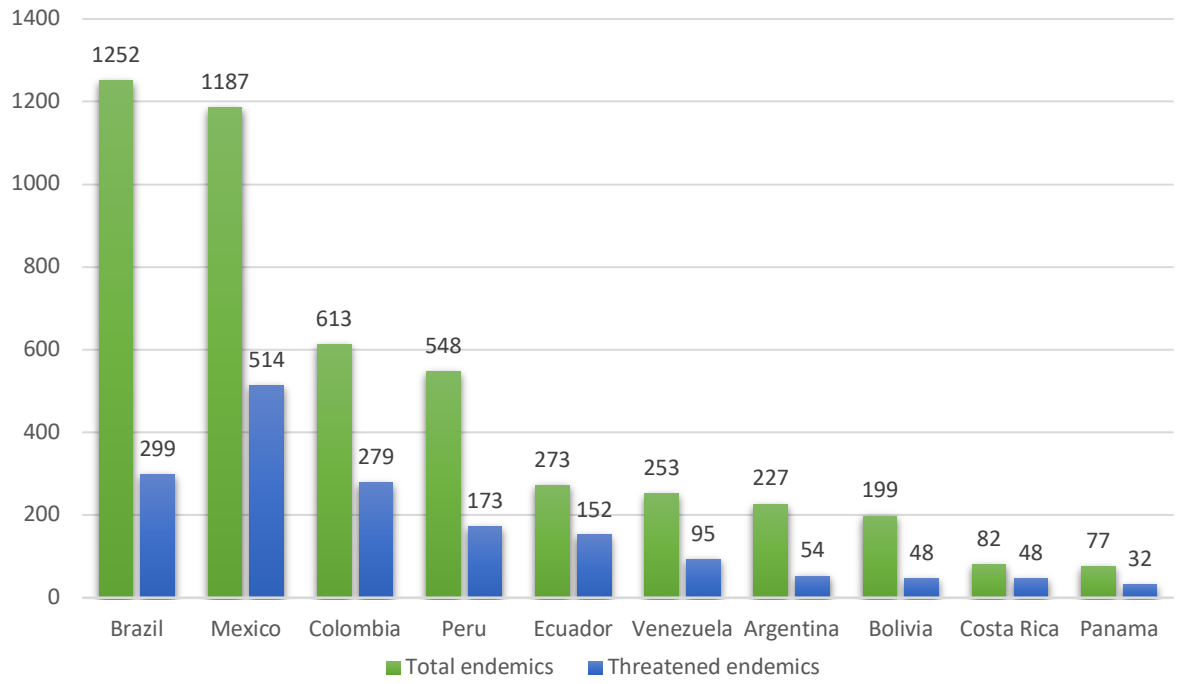
In accordance with Kalin et al. (2004), **The Chilean Winter Rainfall-Valdivian Forests hotspot** comprises the area of central-northern Chile, the northern part of southern Chile, western edge of Argentina and the Juan Fernández Islands. Central-northern part of the Chile is characterized by a winter-rainfall regime, while the northern part of southern Chile is distinguished by rainfall throughout the year. On the whole, the hotspot is home for about 3892 vascular plant species, with half of them endemic, 64 mammal species, of which 13 are endemic. Amphibian and bird diversity is relatively low with 43 amphibian species, of which 29 are endemic and 226 bird species with only 12 endemics. Just like the rest of the hotspots, The Chilean Winter Rainfall-Valdivian Forests hotspot faces a number of threats to its biodiversity:

- habitat degradation and forest clearing;
- plantation forestry;
- overgrazing;
- spread of alien species.

2.4. The loss of biodiversity

The Figure 5 indicates the total number of endemic and threatened endemic species in each country in the year 2017. High pressure on endemic species in those highly diverse countries is very noticeable. It can be seen that the largest number of threatened endemics can be found in Mexico and Brazil. This fact can be explained by the total amount of endemic species in Brazil or Mexico, which is several times greater than in any other country from that chart. Respectively, the amount of threatened species can be also large. Despite the fact that Brazil has the largest number of endemic species, the share of threatened endemics is only 23,8%. According to the figure, the greatest share of threatened endemic species is located in Costa Rica and Ecuador, with 58,5% and 55,6% respectively. That means that out of all endemic species, in those two countries, more than half are threatened. Moreover, in Columbia (45,5%), Mexico (43,3%) and Panama (41,5%) almost half of endemics are threatened. Whereas, in Argentina (23,7%), Brazil (23,8%) and Bolivia (24,1%) almost a quarter of endemic species are threatened. These significant shares of threatened endemics could be also caused by tourism. Bovarnick et al. (2010) affirms that natural tourism enterprises thrive and attract visitors to protected areas, especially to Costa Rica, Panama, Peru and Ecuador which leads to degradation of those protected areas.

Figure 5: Total number of endemic and threatened endemic species in the selected countries



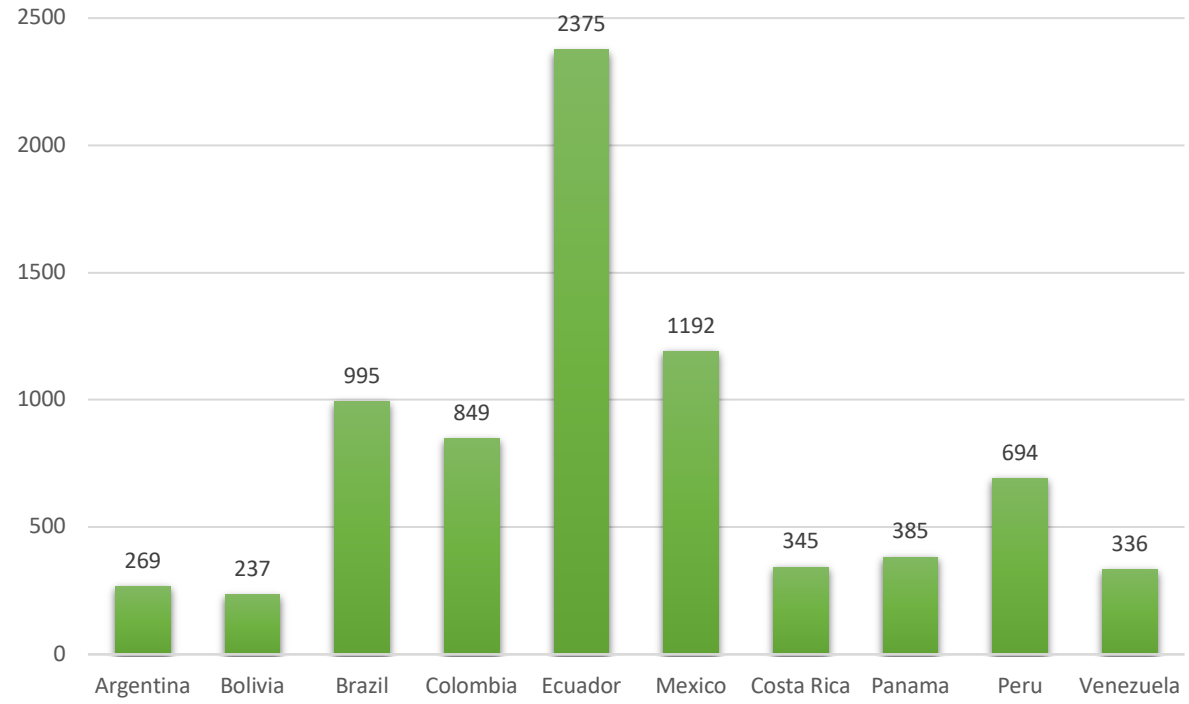
Source: Prepared by the author with data from IUCN, 2017b.

I've been using the data from the IUCN Red List of Threatened Species. The dataset was focused on endemic species in each country and only presented figures for the more comprehensively assessed species groups (i.e., where > 80% of the species in the group have been assessed). By summing up all vertebrates (mammals, birds, crocodiles & alligators, chameleons, amphibians, groupers, sturgeons, wrasses & parrotfishes, sharks & rays), invertebrates (freshwater crabs, freshwater crayfish, lobsters, cone snails, reef-forming corals) and plants (conifers, cycads, cacti, magnolias) in Argentina, Bolivia, Brazil, Colombia,

Ecuador, Mexico, Costa Rica, Panama, Peru and Venezuela, I was able to make a chart, which represents the difference between all the endemic and threatened endemic species in each country. I acknowledge that for some groups, like reptiles, fishes, mollusks or plants, there is still a great deal of species that have not yet been assessed for the IUCN Red List. Nonetheless, those numbers should be interpreted as the number of species known to be threatened within those species that have been assessed to date, and not as the absolute total number of threatened species.

The Figure 6 illustrates the total number of threatened species in the selected countries. According to the chart, the vast majority of threatened species is located in Ecuador (2375), which is the part of the Tropical Andes hotspot - one of the most endangered areas in the tropics. It can be seen from the chart that the highest rates of threatened species are in Ecuador, Mexico, Brazil, Columbia and Peru. According to UNEP (2010a), these five countries are not only among the world's most biologically diverse, but also among the countries with the world's highest number of threatened terrestrial vertebrates.

Figure 6: Total number of threatened species in the selected countries



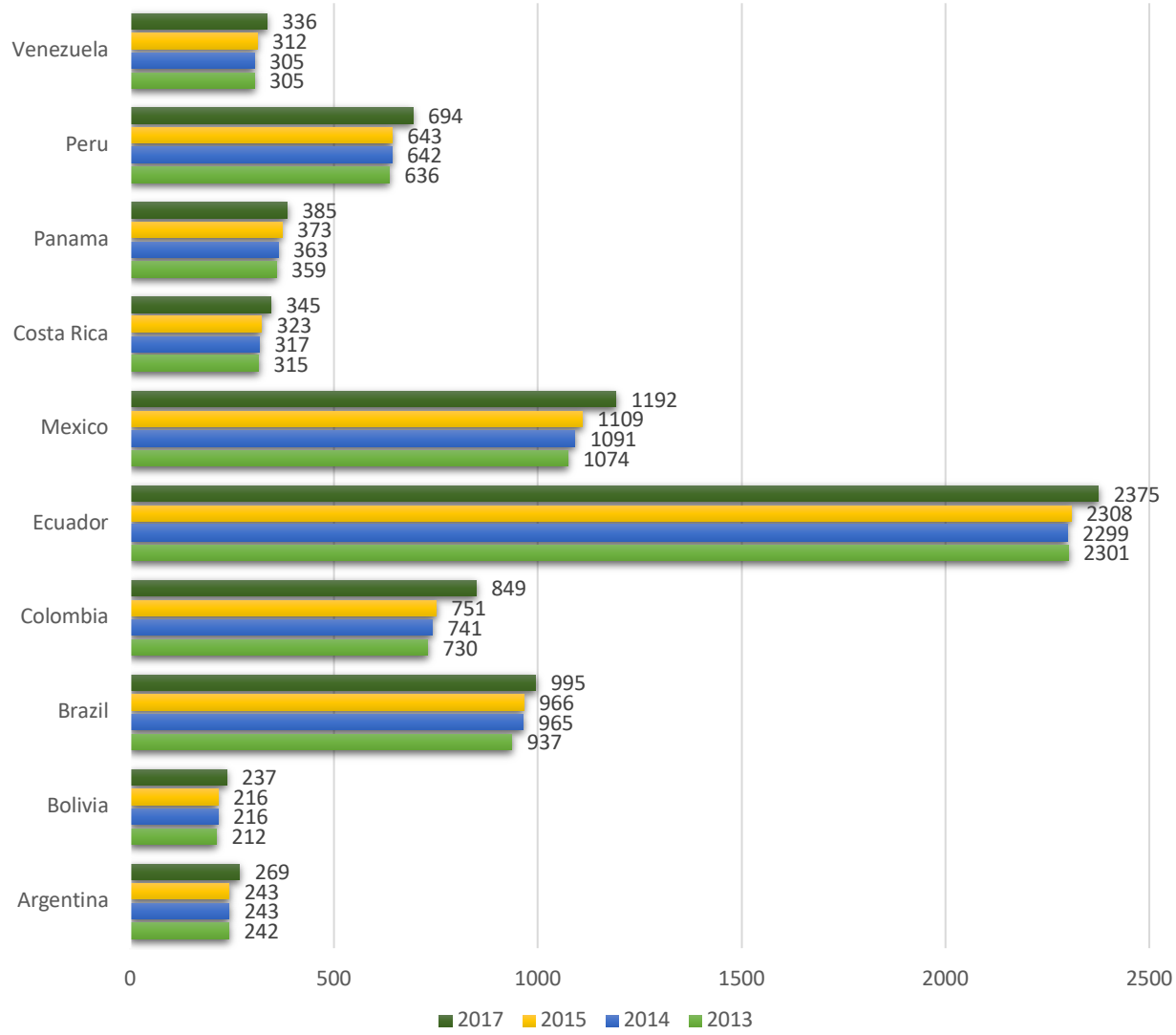
Source: Prepared by the author with data from IUCN, 2017b.

By summing up all of the threatened mammals, birds, reptiles, amphibians, fishes, mollusks, plants and other inverts I was able to make the chart which represents the difference between the number of threatened species in each country. IUCN (2017) affirms, that there are still many species that have not yet been completely assessed for the IUCN Red List. Consequently, this chart should be interpreted as the number of species known to be threatened within those species that have been assessed to date, and not as the overall total number of threatened species.

The Figure 7 gives information about the total number of threatened species in the selected countries between the years 2013 and 2017. According to the chart, in each of those countries the number of threatened species has gradually increased. The greatest increase of threatened

species between the years 2013 and 2017 is observed in Colombia and Mexico with an increase of 119 and 118 species respectively. In Bolivia, Panama and Argentina the quantity of threatened species remained almost the same with a slight increase of 25, 26 and 27 species respectively. Quiroga et al. (2016:11) approves that "*the situation is critical, as between 1996 and 2014, the number of extinct animal species has increased from 99 to 128, the number of critically endangered species has increased from 255 to 1065, and the number of endangered species has risen from 500 to 1624*".

Figure 7: Total number of threatened species in the selected countries between 2013 and 2017



Source: Prepared by the author with data from IUCN, 2013, 2014, 2015, 2017b.
Note: data for the year 2016 was not available.

Bovarnick et al. (2010) argues, that nowadays the shape of ecosystems across Latin America region has deteriorated, which means that the ecosystem resilience - the capacity of an ecosystem to recover from external shocks and pressures - is incessantly reduced. UNEP (2016b) confirms that despite the fact that the rate of transformation of natural systems has begun to slow, the overall rate of loss of ecosystems and species remains high. Bovarnick et al. (2010:23) also identifies factors by which ongoing biodiversity loss and degradation of ecosystems in Latin America are being driven:

- loss of forests;
- unsustainable use of biological resources;
- unsustainable land management practices;
- pollution of ecosystems due to economic activities;
- the spread of alien, invasive species;
- demographic and social factors;
- rapid population growth;
- political factors;
- climate change.

Despite the fact that the region's forests have been used for thousands of years, the rate of deforestation in the region in the last 50 years is among the highest in the world (UNEP, 2010a). According to Global Forest Watch (2016), Brazil places the second place between countries with the greatest tree cover loss between 2001 and 2016, with tree cover loss of 46.37 Mha. In addition, there is also Argentina (5.37 Mha), Paraguay (5.1 Mha), Bolivia (4.07 Mha), Colombia (3.29 Mha), Mexico (3.1 Mha) and Peru (2.37 Mha) in the first twenty. In accordance with FAO (2002), Mha stands for Mega hectare (ha x 10^6).
According to World Bank (2018c), in 1966 the population of the LAC region was 259 million and in the year 2016 the number of the population has grown to 637 million. That means that during the last 50 years the Latin American population grew by 59%. This rapid growth leads to some other problems such as increasing demand for raw materials, untrustworthy ownership of land, increased social inequality and poverty. The LAC region also faces increasing migration to cities, as 80% of the population is urban (World Bank, 2018d). Moreover, there are issues such as weakness and instability of government, corruption and bad policies which can sometimes promote unsustainable activities (for e.g. replacement of forests with cattle farming). In addition, over the past few decades, huge areas of forests, savannahs and meadows have been cleared because of growing demand for soy production. In 2010, 46 million hectares was dedicated to soy production in contrast to 17 million hectares in 1990. Furthermore, soy is being grown mainly on land converted from natural ecosystems, thus putting ecosystems under pressure. Most likely, that worldwide demand for soy will increase, claims WWF (2016b). All these pressures affect not only environment, but the economy itself, as environmental degradation carries real economic costs for countries, which are often unaccounted for (Quiroga et al., 2016).

3. The role of biodiversity in economic growth

Nowadays, *"biodiversity is increasingly recognized as an essential and yet diminishing resource*" (Edwards and Abivardi, 1998:240). Since economic activity is considered as the major driver of the degradation of ecosystem services, it is important to understand major benefits from biological resources in order to sustain them. It is also essential to determine them as goods and services that can be evaluated from the economic point of view and to define all the advantages biodiversity provides (Edwards and Abivardi, 1998). Edwards and Abivardi (1998) provide major categories of values from biodiversity such as values from *direct extractive uses, direct non-extractive uses, indirect uses* and *optional uses*. Values from *direct extractive uses* are, for example, the production of timber, harvesting of plants, stock raising, hunting and fishing. The major type of the *direct non-extractive use* of biodiversity is recreation

and tourism. *Indirect uses* of biological diversity comprise the role of organisms in supplying ecosystem services such as flood control, pest control, photosynthesis, nutrient cycles, soil formation, water, climate and air quality regulation or protection against erosion. The *optional uses*, which considered to be less important, are related with the possible use of a resource in the future. That is, for instance, the possible significance of plants as a source of chemical substances, which are up to now undiscovered (Edwards and Abivardi, 1998). This chapter provides a brief overview of the Latin American economies with an emphasis on ecosystem services and their role in economic growth.

3.1. Sectors of Latin American economies

Latin America have experienced economic growth derived from natural resources. National authorities have promoted sectoral growth to push national economic development. As a result, Latin America has met not only economic growth, but also exhaustion of its natural resources, biodiversity loss and degradation of ecosystem services. Currently, unproductive ecosystem management is the main driver of a relative deficiency of vital ecosystem services (Bovarnick et al., 2010). According to UNEP (2016b), the economies of Latin American countries are highly dependent on its natural resources. Furthermore, a great variety of ecosystems in the region supply different services, such as tourism, fisheries, food, freshwater, etc. They are crucial not only for people's well-being but also for an economic development. The other major example of that kind of services are tropical forests, as they contribute to the global climate regulation, absorbing carbon dioxide and producing oxygen. Bovarnick et al. (2010) provides a description of the most important sectors of Latin American economies, which are highly dependent on the region's biodiversity and ecosystems:

- agriculture;
- fisheries;
- forestry;
- protected areas;
- travel and tourism.

Throughout the region, the agricultural sector makes considerable contributions to export revenues and GDP[1]. Agriculture is the main source of income for rural and poor families and approximately 9% of LAC's population is occupied in that sector. Among the major crops for export are bananas, soybean, coffee, cocoa beans, avocados, pineapples and beat sugar. In spite of the fact that agricultural sector provides contribution to Latin America's GDP, it also leads to water pollution and habitat loss, which negatively affect biodiversity of the region. In addition, unsustainable agriculture activities decline ecosystem services and lead to soil erosion. As a consequence, agricultural potential becomes weaken and the future returns could decrease.

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[1] "*Gross domestic product, or GDP, is the total value of all final goods and services produced in an economy during a given period, usually a year. It does not include the value of intermediate goods and services*" (Krugman et al., 2014: 328; 342).

The fisheries sector is also very important in many countries of the region, contributing to Latin America's GDP, food production, working places and domestic income. Moreover, it is a source of healthy food for a great number of people. Latin America and the Caribbean is among the most considerable fishery regions in the world. The main countries that are benefiting from this sector are Mexico, Brazil, Colombia, Chile, Argentina, Peru, Panama, Venezuela. Moreover, Peru is the second largest fish producer in the world. The fisheries sector is providing more than 1% of GDP in these countries. Nowadays, most fishery resources in the region are overexploited or depleted (Bovarnick et al., 2010).

A significant amount of people is employed in forestry sector. This sector comprises activities like forestry and logging; sawn wood production and wood-based panels; pulp and paper production (FAO, 2017). Logging and related forestry activities are contributing somewhere about 2% to Latin America's GDP. Moreover, forests possess considerable potential for creating continuous economic production on the basis of ecosystem services such as water, food, timber and non-timber forest product production and tourist destinations (Bovarnick et al., 2010). According to FAO (2017) estimations, the formal contribution of the forestry sector to the regional economy amounted to 49 billion US dollars (at 2011 prices), from a global contribution of 606 billion US dollars. Unfortunately, as long as the loss of forested areas continues, the capacity of extraction of local environmental goods and services will be reduced. It can lead not only to the loss of economic revenues and future jobs but also to declines in the tourism demand (UNEP, 2016b). The loss of forests also leads to habitat loss, consequently, to populations decline and extinction of species. Sustainable forest management and forests themselves are crucial for the majority of the Sustainable Development Goals (SDGs). They are significant in providing goods and services that contribute not only to socio-economic development but also to environmental protection and sustainability (FAO, 2017).

According to World Travel & Tourism Council (2017), the total contribution of travel and tourism to Latin America's GDP in 2016 was 328.2 billion US dollars, which makes up 8.8% of GDP and is ranked fourth in the world. Moreover, it is expected to rise by 3.5% per annum to 473.0 billion US dollars (9.4% of GDP) in 2027. Furthermore, tourism sector generated almost six million jobs directly in 2016, which composes 2.9% of total Latin America's employment. This comprises work of all the hotels, travel agencies, air and land transportation services, restaurant and recreation industries directly supported by tourists.

All of the protected areas, terrestrial and marine, ensure essential ecosystem services to all of the sectors above. National parks and protected areas create a significant benefit for the region. It is estimated that there are 4000 visits per year in each protected area in Latin America and the Caribbean (UNEP-WCMC, 2016a). Apart from providing employment, natural reserves are also contributing to the region's GDP and local development. Ricardo Sánchez Sosa, a former regional director for Latin America and the Carribean (UNEP), states that *"The Protected Natural Areas contain the greatest natural diversity of every country. They are unique spaces for the conservation of the natural capital. They must become the strategic spaces for the development of nations and a subject of natural security*" (Guerrero and Sguerra, 2009: 6).

In accordance with Krugman et al. (2014: 329), "*the value added of a producer is the value of its sales minus the value of its purchases of intermediate goods and services*". The figure 8 below indicates the percentage of value added by agriculture, forestry and fishing between 2006 and 2016 in Costa Rica and Mexico and between 2006 and 2014 in Brazil. It is seen that the value added in Costa Rica has declined form 9.384% in 2006 to 5.658% in 2016. In Brazil the percentage of value has fluctuated at the level of five per cent during the observed years. Despite

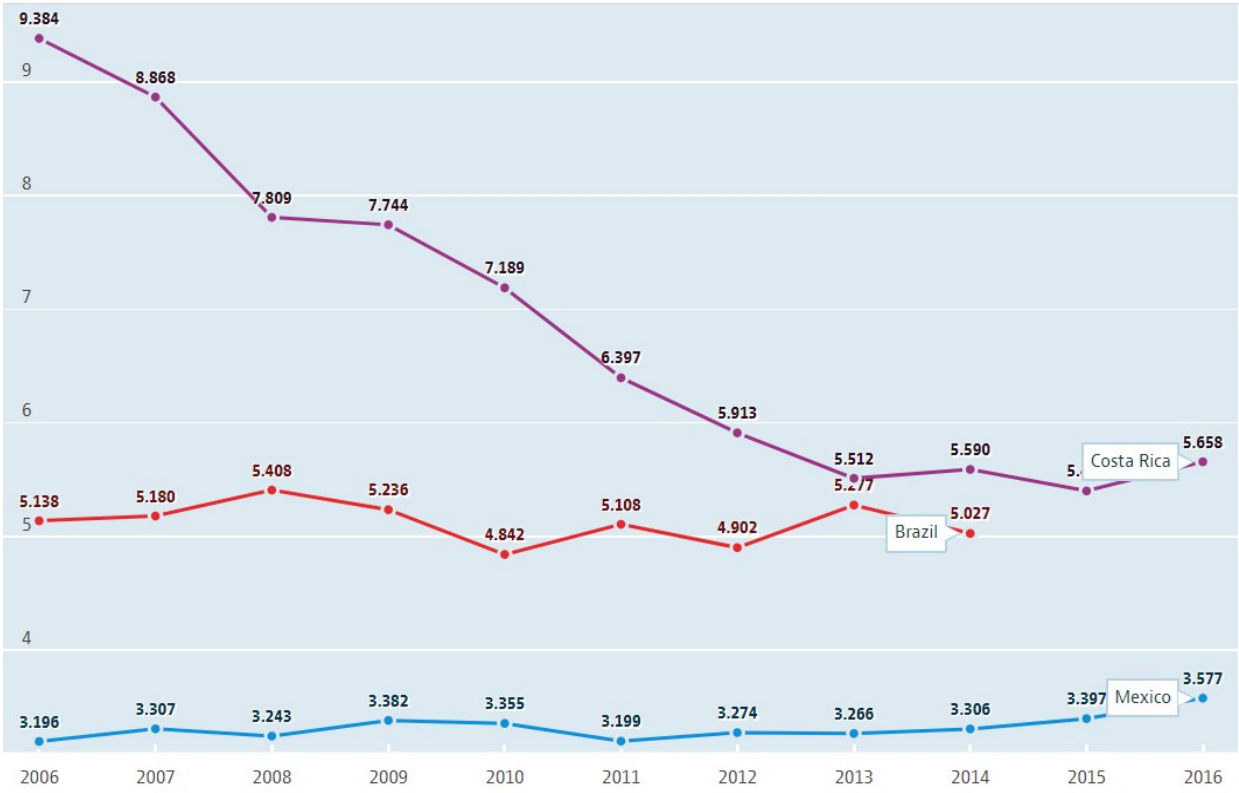
the fact that Mexico indicates the lowest percentage of value added by agriculture, forestry and fishing, the country now shows the highest percentage in the last ten years (3.577%).

Table 4: Travel and tourism's total contribution to GDP

TRAVEL & TOURISM'S TOTAL CONTRIBUTION TO GDP		2016 (US$bn)
1	North America	1771.3
2	European Union	1682.9
3	North East Asia	1522.6
4	Latin America	328.2
5	South East Asia	301.1
6	Other Europe	278.5
7	South Asia	252.9
8	Middle East	227.1
9	Oceania	182.7
10	Sub Saharan Africa	108.0

Source: Modified from World Travel & Tourism Council, 2017.

Figure 8: Value added by agriculture, forestry and fishing



Source: OECD, 2018a.

Note: this information was available only for these three countries of the region.

According to the examples given above, we can conclude that biodiversity and ecosystem services have a significant influence on economic growth and productivity. It can be also seen that the sectors of Latin American economies are influencing biodiversity of the region as well. Moreover, Bovarnick et al. (2010) state that there is a significant contribution of ecosystem services to economic growth and that ecosystem services should be considered as inputs into sectoral outputs. Productivity in agriculture, for example, is determined by water quality and availability, soil fertility and microclimate. Timber and non-timber forest product production is also dependent on water, microclimate, soil moisture and soil fertility. In addition, soil stabilization, pollination, biodiversity and gene pools are also influencing this type of sector. The most important inputs of marine ecosystem services to fisheries are not only providing fish with vital habitats and food chains, but also supporting temperature control and water filtration. These inputs are essential to ensure favorable environment for fish, hence, for fisheries. In tourism, which is considered as an important economic activity, the major ecosystem services are water quality, biodiversity and attractive views (Bovarnick, 2010). However, with the loss of biodiversity, the demand for tourism-related services decreases, because of the reduction of the aesthetic value of the environments (UNEP, 2016b). Moreover, inappropriate tourism management leads to degradation of protected areas.

3.2. Exports

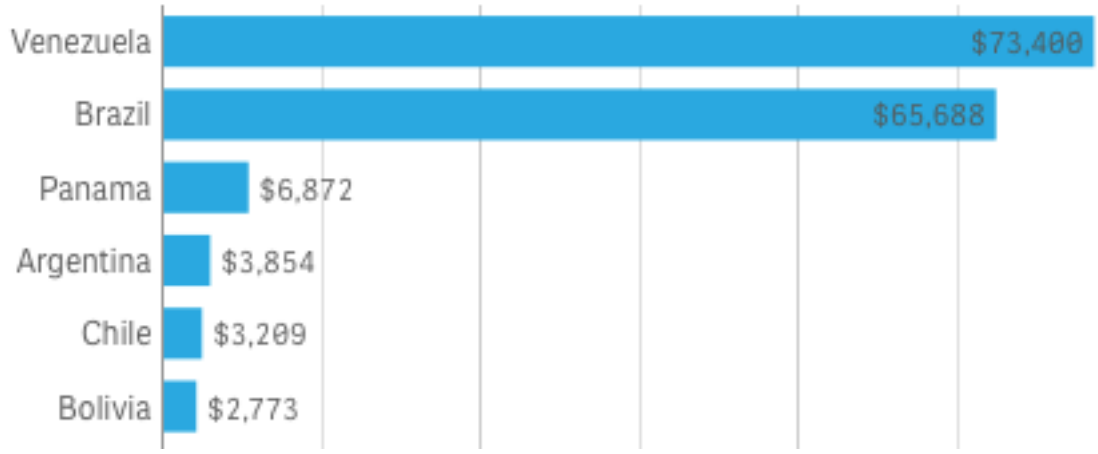
According to United Nations 2016 International Trade Statistics Yearbook (2017), between 2013 and 2015 in Venezuela, Panama, Bolivia and between 2014 and 2016 in Peru, Costa Rica, Mexico, Ecuador, Columbia, Brazil and Argentina the largest commodity groups for exports were:

- **Venezuela**: Petroleum oils; acyclic alcohols and their derivatives; ferrous products obtained by direct reduction of iron ore; iron ores and concentrates; mineral or chemical fertilizers; ammonia (anhydrous or in aqueous solution).
- **Panama**: Bananas, including plantains, fresh or dried; crustaceans, whether in shell or not; fish, fresh or chilled, excluding fish fillets; flours, meals and pellets, of meat or meat offal; ferrous waste and scrap; remelting scrap ingots of iron or steel; figs, pineapples, avocados and mangosteens, (fresh or dried); wood in the rough, whether or not stripped of bark or sapwood; cane or beet sugar and chemically pure sucrose (in solid form); gold; alcohol.
- **Bolivia**: Petroleum gases and other gaseous hydrocarbons; zinc ores and concentrates; gold; precious metal ores and concentrates; petroleum oils and oils obtained from bituminous minerals; unwrought tin; soya-bean oil and its fractions; coconuts, Brazil nuts and cashew nuts, (fresh or dried).
- **Peru**: Copper ores and concentrates; gold; petroleum oils (other than crude); unwrought refined copper and copper alloys; zinc ores and concentrates; flours, meals and pellets (of meat or meat offal); lead ores and concentrates; coffee, whether or not roasted or decaffeinated; grapes (fresh or dried).
- **Costa Rica**: Instruments and appliances used in medical, surgical, dental or veterinary; bananas (including plantains, fresh or dried); figs, pineapples, avocados and mangosteens, (fresh or dried); electronic integrated circuits; orthopaedic appliances (including crutches, surgical belts and trusses); food preparations; coffee, whether or not roasted or decaffeinated; fruit juices (including grape must) and vegetable juices; new pneumatic tyres of rubber.

- **Mexico**: Motor cars and other motor vehicles; parts and accessories of the motor vehicles; petroleum oils and oils obtained from bituminous minerals (crude); automatic data processing machines; electrical apparatus for line telephony or line telegraphy; reception apparatus for television.
- **Ecuador**: Petroleum oils; bananas (including plantains, fresh or dried); crustaceans, whether in shell or not; prepared or preserved fish; caviar; cut flowers and flower buds of a kind suitable for bouquets; gold; cocoa beans (whole or broken, raw or roasted); palm oil and its fractions.
- **Columbia**: Petroleum oils; coal; coffee, whether or not roasted or decaffeinated; gold; cut flowers and flower buds of a kind suitable for bouquets; bananas (including plantains, fresh or dried); ferro-alloys; medicaments; insecticides, rodenticides, fungicides, herbicides.
- **Brazil**: Soya beans, whether or not broken; iron ores and concentrates; petroleum oils and oils obtained from bituminous minerals (crude); cane or beet sugar and chemically pure sucrose (in solid form); meat and edible offal; coffee, whether or not roasted or decaffeinated; chemical wood pulp, soda or sulfate; maize; meat of bovine animals (frozen).
- **Argentina**: Soya-bean oil and its fractions; soya beans, whether or not broken; maize; motor vehicles for the transport of goods; gold; wheat and meslin; biodiesel and mixtures thereof.

Among all the ten countries studied, only Venezuela and Mexico did not have any agricultural products among the largest commodity groups for exports. These two countries are basically focused on the export of the petroleum oils, because they have large oil reserves. Almost all of the ten studied countries, except for Venezuela and Mexico, are exporting bananas, soya beans or its oil, cane or beet sugar, coffee, cocoa beans, pineapples and avocados in large quantities. In addition, Ecuador and Columbia are exporting a significant amount of cut flowers and flower buds of a kind suitable for bouquets, and Brazil and Argentina are exporting maize. Apart from food products, among the largest commodity groups are motor cars and other motor vehicles, telecommunication sound equipment, gold, zinc ores, metal ores, iron ores, mineral or chemical fertilizers and medicaments.

Figure 9: Net exporting countries (MLN US $)

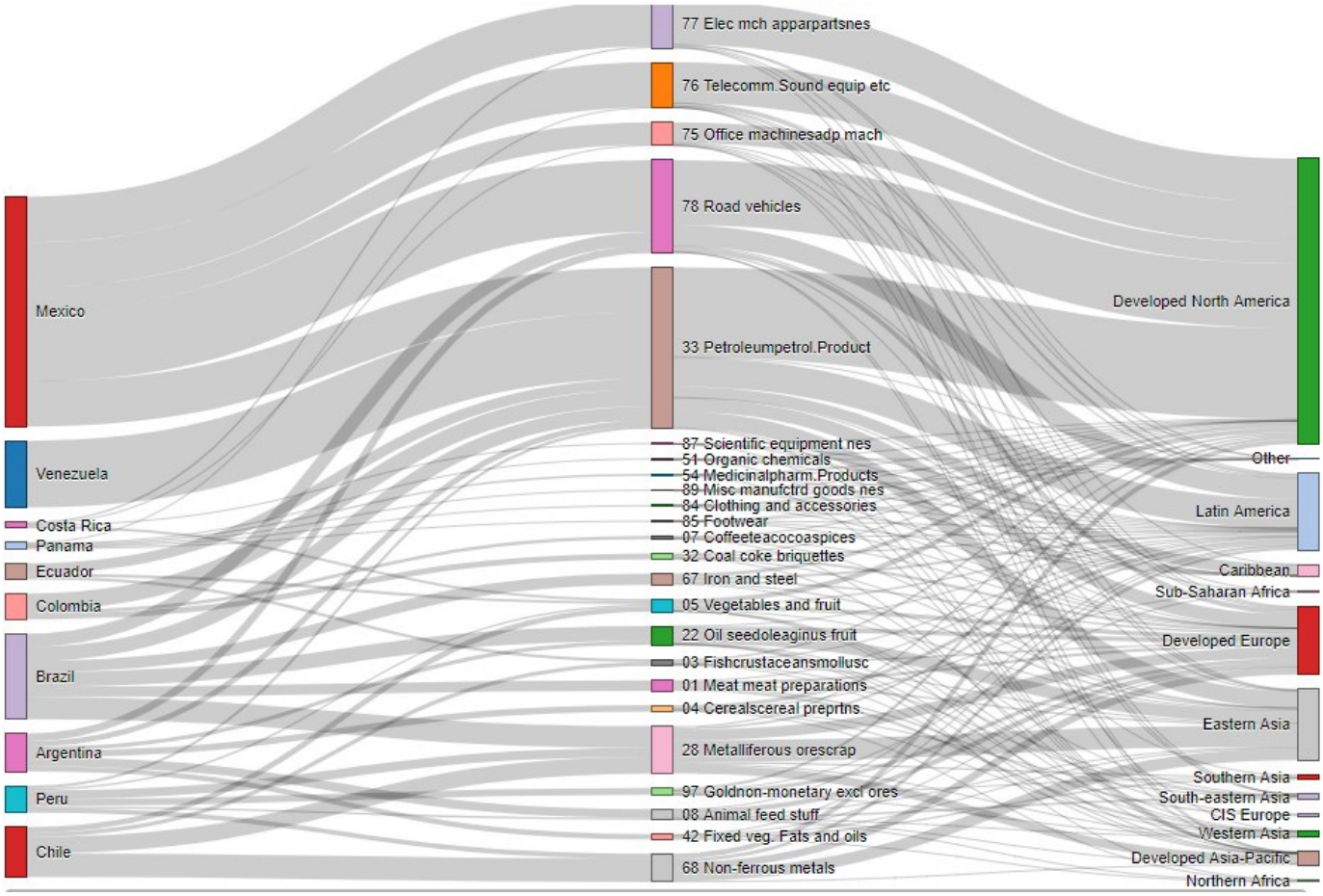


Source: United Nations Comtrade database; 2017.

The vertical bar chart of net exporting countries above, indicates the net trade values (exports minus imports) in Venezuela, Brazil, Panama, Argentina, Chile and Bolivia between 2013 and

2016. Only the countries with positive values were chosen. All other Latin American countries have negative values. The worst net trade values between 2013 and 2016 were indicated in Colombia (-41923 $), Mexico (- 32169 $) and Guatemala (-28186 $). This means that they are importin more than exporting. The Sankey chart below displays the relation between exporters, traded goods, and destination of exports. The size of the flow indicates values of trade.

Figure 10: Main export flows (exporter -> commodity -> destination)



Source: United Nations Comtrade database; 2017.

3.3. Is there any relation between biodiversity and economic growth?

First of all, it is essential to understand the definition of economic growth. Krugman et al. (2014: 4; 32) define economic growth as "*the growing ability of the economy to produce goods and services*", as "*an expansion of the economy's production possibilities*". In addition, the authors introduce two fundamental sources of economic growth, which are: an increase in factors of production, the resources with the help of which goods and services are produced (for e.g. land, capital, human capital and employment) and an advancement in technology.

There is a wide range of opinions concerning the relationship between biodiversity and economic growth. Some authors argue, that economic growth negatively affects biodiversity, others assert that there is no relationship between them both. For example, Fuentes (2011) supports the opinion of no crucial connection between them, because it is feasible to have safe

and sustainable biodiversity and economic growth at the same time. Moreover, Fuentes (2011: 3453) affirms that "*we are losing biodiversity because of human preferences and human inefficiencies, not because of economic growth*". On the other hand, Czech et al. (2012) provide empirical data in confirmation of a conflict between economic growth and biodiversity in which threatened species are strongly correlated with population and GDP. In Latin America, according to Bovarnick et al. (2010), biodiversity plays an important role in economic growth because of the significant effect biodiversity has on ecosystem services and they in its turn affect the productivity. However, presently, biodiversity loss and degradation of ecosystem services is driven by several different factors like climate change, population growth, economic activities, unsustainable use, the spread of alien species and weak government. Thereby, I think that it cannot be definitely said that economic growth is the only one and the main driver of the biodiversity loss as there is a lot of other pressures. It can only be said that those two are surely related. Firstly, because of the biodiversity's effect on productivity. Secondly, because of the impact of the economic activities on biodiversity. I believe, that sustainable use is needed for the region as it will save biodiversity and therefore promote economic growth. According to UN (1992a: 4), "*sustainable use means the use of components of biological diversity in a way and at a rate that does not lead to the long-term decline of biological diversity, thereby maintaining its potential to meet the needs and aspirations of present and future generations*". Heraldo Munoz, the regional director of the Bureau for Latin America and the Caribbean, states that *"the sustainable use of biodiversity and ecosystem services is not only the key to economic development, but is also of vital importance to human development, if used wisely"* (Bovarnick et al., 2010: III – preface). Moreover, it will contribute to sustainable economic growth, which means "*growth that balances economic, social, and environmental considerations*" (OECD, 2011b: 2).

4. Protected areas

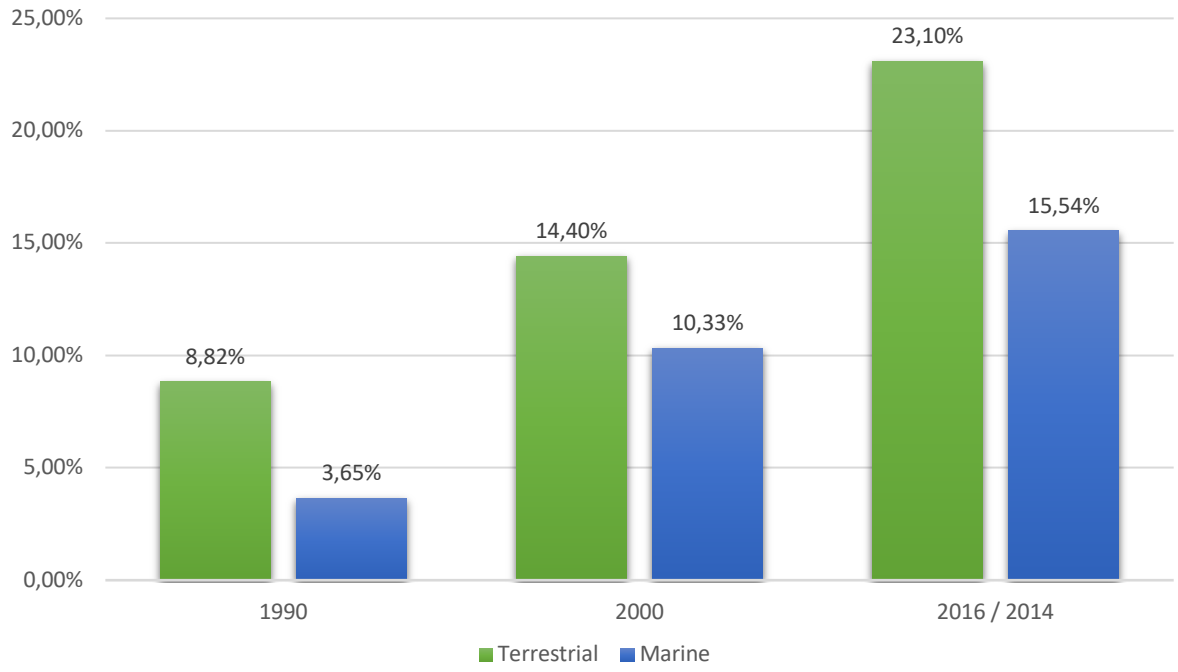
According to United Nations' Convention on Biological Diversity (UN, 1992a: 4), "*Protected area means a geographically defined area which is designated or regulated and managed to achieve specific conservation objectives*". Then, 16 years later, International Union for Conservation of Nature (2008: 8) defined protected area as *"a clearly defined geographical space, recognized, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values"*.

Protected areas are significantly important for the region as they preserve a substantial amount of the natural capital. They are not only providing the source of clean air, water, medicines and contributing to conservation of biodiversity and ecosystems but also ensuring a wide range of social and economic benefits, like job places, tourist destinations, aesthetic values and so on. Appropriately managed protected areas guarantee not only pleasure of natural environment but also ecologically sustainable land use of the terrestrial areas along with benefits from fisheries in marine areas. According to Guerrero and Sguerra (2009), the first Congress on National

Parks and Other Protected Areas of Latin America and the Caribbean was held in Santa Marta, Colombia, in 1997 and the second one was held in 2007 in Bariloche, Argentina. They both proved that protected areas are important tools for the region's development and sustainability. Important tasks like including the protected areas in the development and sector plans of public policies and ensuring their effective protection were set in these two meetings.

UNEP-WCMC (2016a) asserts that LAC countries have been working at the national and regional level truly hard to put into effect the *Strategic Plan for Biodiversity 2011-2020*. The report also affirms that one of the best trends in the region is seen in **Target 11**, which concerns protected areas: *"By 2020, at least seventeen per cent of terrestrial and inland water, and ten per cent of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services, are conserved through effectively and equitably managed, ecologically representative and well-connected systems of protected areas and other effective area-based conservation measures, and integrated into the wider landscapes and seascapes"* (UNEP-WCMC, 2016a: 70). A large-scale network of protected areas, which is now making attempts to increase its efficiency, has been established in the region. The network consists of national, community and private reserves (UNEP-WCMC, 2016a). The data from the World Bank confirms it and it is seen from the figure 11 below that the coverage of protected areas between 1990 and 2016 has expanded significantly. In accordance with the World Bank (2018a) data, the percentage of terrestrial protected areas in LAC composed 23.1% of the total land area in 2016. In contrast to the year 1990, when protected areas covered only 8.8% of the region. The percentage of the marine protected areas has also increased. In 1990 it composed 3.6% and in 2014 marine protected areas made up 15.5% of territorial waters.

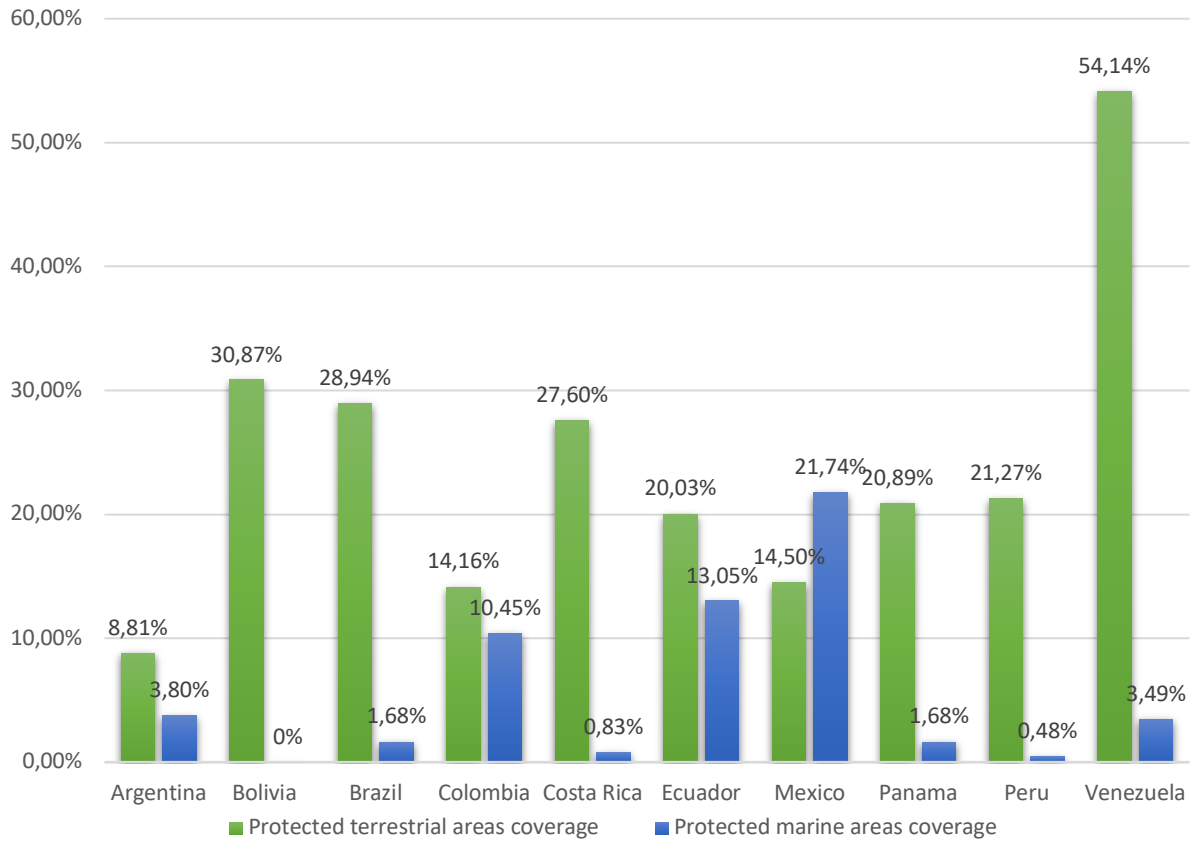
Figure 11: Percentage of terrestrial and marine protected areas in LAC



Source: Prepared by the author with data from the World Bank, 2018a,b.

The next figure shows the coverage of terrestrial and marine protected areas in the selected countries. It can be seen, that more than half (54%) of Venezuela is covered with terrestrial protected areas. Among ten studied countries, Argentina has the lowest (8%) coverage of terrestrial protected areas. All the other countries are located in the middle, with the percentage of protected areas fluctuating from 14% to 30%. Despite the fact that Mexico has one of the lowest coverages of terrestrial protected areas, it has the biggest coverage of marine protected areas. Bolivia is a landlocked country and does not have any marine protected area. The amount of protected areas in the selected countries varies greatly. It can be seen in the table 5, that Brazil has the largest number of protected areas and Ecuador has the lowest. It can be explained by the size of the country, as the number of protected areas is strongly correlated with the total area of the country.

Figure 12: Protected terrestrial and marine areas coverage in the selected countries



Source: Prepared by the author with data from UNEP-WCMC, 2018b.

Table 5: Total area in square kilometers; number and coverage of protected areas in the selected countries

	Number of protected areas	Total area km²	Protected terrestrial areas coverage	Protected marine areas coverage
Argentina	385	2780400	8,81%	3,80%
Bolivia	167	1098580	30,87%	0%
Brazil	2199	8515770	28,94%	1,68%
Colombia	621	1141749	14,16%	10,45%
Costa Rica	187	51100	27,60%	0,83%
Ecuador	76	256370	20,03%	13,05%
Mexico	1192	1964380	14,50%	21,74%
Panama	95	75420	20,89%	1,68%
Peru	244	1285220	21,27%	0,48%
Venezuela	251	912050	54,14%	3,49%

Source: Prepared by the author with data from UNEP-WCMC, 2018b and World Bank, 2018a,b.

The other question is: does the quantity of these protected areas correspond to the quality of the management? According to the survey of Guerrero and Sguerra (2009), one the biggest trends of the period between 1997 and 2007 was growth in the quantity of units for the conservation of protected areas, but the management was weak and ineffective. It is also mentioned in UNEP-WCMC (2016a), that there are more than 54% of protected areas in the region, which considered to be effective and 23% which are not. Moreover, it is supposed that the current network of protected areas will not cope with restraining the loss of biodiversity and the degradation of ecosystems in the region. Weak management, badly-equipped protected area institutions, deficiency of corresponding legal and control frameworks and poor understanding of the consequences of loss of ecosystem services are the main drivers of insufficiency of protected areas. Furthermore, there are a lot of threats to protected areas in the region, such as climate change, unsustainable exploitation and overexploitation of natural resources, loss of natural environment and habitat degradation and badly-controllable tourism sector (Bovarnick et al., 2010). However, national reports to the Convention on Biological Diversity assume, that there are 9 countries in the region, which are on the way of achieving or exceeding the Target 11. There are few details concerning their efficiency, though (UNEP-WCMC, 2016a).

Conclusion

Overall, Latin America is one of the world's most biologically diverse regions, which is among the regions with the highest diversity of terrestrial mammal species, has the greatest density of amphibian species and also has the second place in plant diversity on Earth. The region has six out of world's 35 biodiversity hotspots, so it is one of the planet's greatest centers of endemic diversity. Unfortunately, the shape of ecosystems across Latin America has deteriorated as the region is facing unsustainable use of biological resources, unsustainable land management practices, deforestation, pollution of ecosystems due to economic activities, rapid population growth, climate change and other pressures that negatively affect biodiversity. Moreover, the number of threatened species has increased between the years 2013 and 2017 and the highest rates of threatened species can be found in Ecuador, Mexico, Brazil, Columbia and Peru.

Biodiversity loss and degradation of ecosystem services is driven by several different factors. One of them is economic activity. The most important sectors of Latin American economies are: fisheries, agriculture, forestry, protected areas and tourism. All of these sectors provide contribution to Latin America's GDP, employment and food production. Furthermore, these sectors are immensely dependent on biodiversity and ecosystem services, such as climate and water regulation, erosion and air quality regulation, water purification, pollination, nutrient cycling, soil formation, photosynthesis, recreation and aesthetic values. In their turn, these sectors affect biodiversity rather negatively, than positively. For example, agricultural activities lead to water pollution, deforestation, soil erosion, habitat loss and habitat degradation. Fisheries are overexploited. Deforestation also leads to habitat loss and extinction of species. The application of sustainable agricultural practices is needed for the region, as it will help to support the natural resource base. In addition, new policies concerning sustainable use of biodiversity should be adopted, as they will contribute to sustainable economic growth and will protect biodiversity of the region.

Nevertheless, Latin America is making significant attempts to put into effect the Strategic Plan for Biodiversity 2011-2020. The coverage of terrestrial protected areas has significantly increased from 8.8% in 1990 to 23.1% of in 2016. The coverage of marine protected areas has also increased from 3.6% in 1990 to 15.5% in 2014. The biggest amount of protected areas can be found in Brazil, the lowest - in Ecuador. However, most of protected areas within the region are considered to be weak and ineffective. Moreover, in some countries, improper tourism management leads to degradation of protected areas. As stated by Heraldo Munoz, "*if degradation continues, many of the region's most vulnerable peoples, in particular indigenous communities, will be without a source of food, income, or habitat in which they have built their lives and traditions over the centuries*" (Bovarnick et al., 2010: III Preface).

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