Conservation of Biological Resources: Why Does It Matter?

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Abstract

The world population has grown from 2500 million people in the year 1950 to more than 7300 million people in the year 2015, posing a challenge never faced before in human history. People are less aware about the limitedness of natural resources and the consequences of the present development. Increased population, associated with technological advancement undermines the sustainable development of any nation. Daily, many species are going extinct due to the continuous fragmentation/destruction of habitats, many of which have not been studied or referenced. Presently, we are living in the «Decade of Biodiversity» from the period of year 2011 to the year 2020, which was launched at the end of the year 2011 by the General Secretary of the United Nations, Ban Ki-moon. This poses a great challenge and all societies and nations are saddled with the responsibility of revising their actual models of economic development and increasing their knowledge base, by planning more intelligent and integrative programmes for the conservation of our biological resources and its functions in the ecosystems and human health. This chapter aims to raise awareness on the relevance of biodiversity in people's life. It emphasizes subjects, such as the importance of forests, the unknown biodiversity, and the extinction of species, in order to alert the general public, students, teachers, and other stakeholders to the importance of all biological resources.

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1 Introduction

A comprehensive knowledge of the natural systems and of the living beings that inhabit them, together with the relationship they establish between themselves and the environment, is far from being assembled and understood. Despite new technologies and study methodologies, such as the application of Remote Sensing or the use of Geographic Information Systems (GIS) which allowed us to study areas that were inaccessible and observe organisms at scales that were never considered. However, the huge biodiversity of the Earth's ecosystems is yet to reveal all its secrets!

Among the numerous living organisms that inhabit our Planet, *Homo sapiens*, is certainly the species that cause more and serious environmental impacts. The tools we have at our disposal have shown impressive signs of the habitat destruction, particularly, the forest system (Food and Agriculture Organization [FAO] 2015). Given the undeniable facts of environmental destruction (FAO 2015; Vitousek et al. 1997), the traditional human perception of nature's equilibrium is severely affected. In this present phase in which we live, the unbridled consumption of resources (European Environment Agency [EEA] 2015; Giljum et al. 2009; Kovanda and Hak 2011) is evident and brings incalculable costs.

The extreme and rapid expansion of human population (Fig. 1) and its model of economic development that encourages the unbridled consumption of goods and services demean the services provided by the different ecosystems and its resources (EEA 2015). In the mid-2015, the total population reached an incredible number of 7349 million (United Nations [UN] 2015) (Fig. 1a), and it is expected to grow above 50 % in the year 2100 (Fig. 1b).

Each living human, needs basic resources and almost all people seek to utilize significantly more and more resources. These expected demands multiplied by a factor of 7.3 billion (and growing rapidly) compromise the stability of the planet's system. Thus, the people do not only realize how we pollute the "cage" (Earth) in

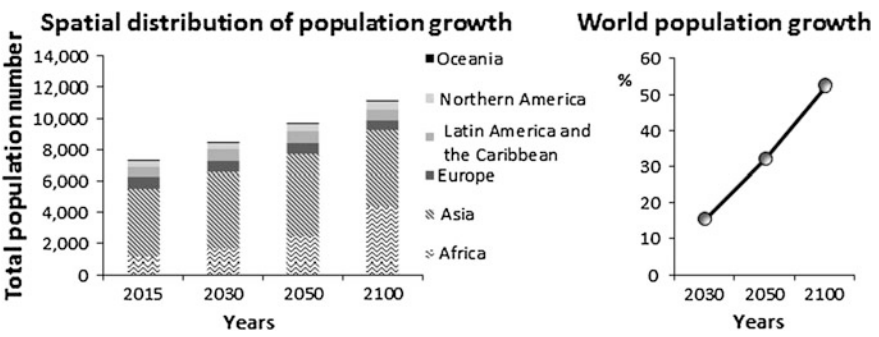

Fig. 1 Estimation of total population growth and its main spatial distribution worldwide according to the medium-variant projection. Adapted from: UN, Department of Economic and Social Affairs, Population Division (2015). World population prospects: the 2015 revision

which we live, but also destroy the nature, daily eliminating species, many of which, have not been studied.

The present chapter aims to contribute to the knowledge and understanding on the relevance of biodiversity in every one's life, and clarify the reasons to take action towards the conservation of the biological resources. It underlines on issues, such as the role of forest ecosystems, alert to the unknown biodiversity, and to the extinction of species.

2 Reasons for Taking Action

The laws of physics (mass conservation, conservation of energy, and entropy laws) are fundamental to the understanding and conservation of ecosystems: no system can create or eliminate matter, it can only be transformed; energy can neither be created nor destroyed (the energy conversion process involves the loss of quality); and everyone constantly needs energy to maintain its low entropy (Fig. 2).

These messages are quite clear: the earth is finite and its ability to absorb wastes and polluted effluents is also finite. The capacity to provide all the resources for human survival is thus finite, and current economic practices which damage the environment, in both developed and underdeveloped nations, cannot be continued.

All human activities make use of the services of the ecosystems and put pressure as well, on the biodiversity that supports these services: (a) Habitat loss, alteration, and fragmentation—for instance, through the land use change for aquaculture, industrial or urban use; the construction of dams and other changes in river systems for irrigation, hydropower or adjustment of current and harmful fishing activities; (b) Overexploitation of populations of wild species—for instance, the harvesting or killing of animals or plants for food, materials or medicine at unsupported natural rates of its reproduction; (c) Pollution—for instance, the excessive use of pesticides in agriculture and aquaculture; urban and industrial effluents and waste mining; (d) Climate change—for instance, the rising levels of greenhouse gases in the

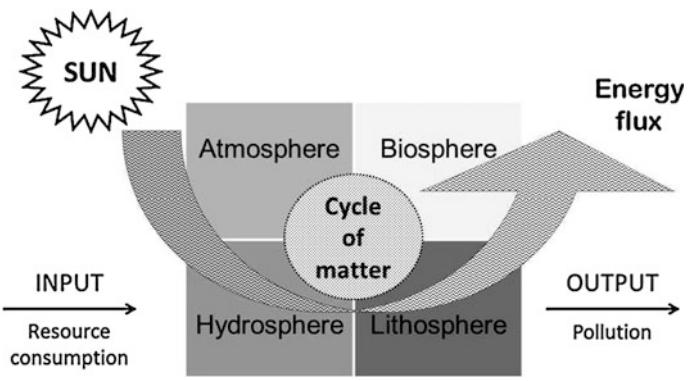

Fig. 2 Schematic representation of energy and matter fluxes in our planet

atmosphere, mainly caused by burning of fossil fuels, deforestation and industrial processes; and (e) Invasive species—for instance, the introduction (on purpose or inadvertently) of exotic species that become very competitive, parasites or predators of native species (Alberti 2015; Davidson et al. 2014; Doney et al. 2012; EEA 2015).

Very few people realize that, presently, we are living in the "Decade of Biodiversity" launched by the UN in the year 2011. This decade is of extreme importance, so that people may realize that we cannot survive without biodiversity. Taking actions to inform and raise more awareness about the problems caused by the continuous destruction of habitats, loss of biodiversity and the link between biodiversity, ecosystem's services and human well-being is therefore, urgent. The extinction of species cannot be reverted, but it is possible to avoid future extinctions of other species if appropriate programmes are implemented, mainly for those who are at high risk of extinction.

3 Forests' Ecosystems and Species Richness

The knowledge of spatial variation in species richness and the diversity along environmental gradients is a central theme in ecology, as they harbour a large part of the terrestrial biodiversity and provide a wide range of ecosystem services and economic growth (EEA 2010). We know that the forests, particularly, the equatorial forest (*pluvisilva*), due to a higher plant biomass production, are unique systems, embracing high levels of biodiversity (Kier et al. 2005; Kraft et al. 2011).

Among plant species, there are huge differences in the amount of biomass produced and on the volume of CO_2 consumed. Among the dominating tree's ecosystems, moist tropical forests (*pluvisilva*) are hot spots for plant richness (Barthlott et al. 2007; Gaston 2000), because, by virtue of being on the equatorial zones, they have a constant energy and water source available. Another recent example of these equatorial zones is in the work of Collen et al. (2014), which showed that absolute freshwater diversity was highest in the Amazon Basin.

A study conducted by Kier et al. (2005) proved that tropical and subtropical moist broadleaf forests were the ecosystems with higher plant richness (3161 taxa), followed by Mediterranean forests with 2294 taxa. These two types of forest systems play an important role in biodiversity and in the survival of other species. Despite the fact that there are no co-existing link between tree canopy height and diversity in all regions of the world, the Afrotropic realm richness shows an increase in diversity with tree canopy height, mostly for amphibians, a very slight increase in birds and none for mammals (Roll et al. 2015).

It is also known, that living organisms (biodiversity) constitute our food source, provide us with medicinal substances, clothing (practically, everything we wear is of animal or vegetable origin), energy (for example, firewood, petroleum, waxes, resins), construction materials, and furniture (wood), among other goods. A large part of the electrical energy consumption would not be possible without the

contribution of other living beings. Other evidence is that *Homo sapiens* appeared in ecosystems which support most of the earth's biodiversity—the African tropical forests. In addition, it is constantly discovered new uses of plants, animals, and other organisms.

Despite this knowledge, the cutting down of forests continues and land is drastically reclaimed for other uses (Barthlott et al. 2007; Chen et al. 2013). It can be observed from the report on forest global assessment (2015) by FAO of the UN that the loss of forest systems is still happening. In the year 1990, the global forest area was estimated at 4,128,269 ha and in the year 2015, 3,999,134 ha was the total area measured by FAO (FAO 2015). For example, in Brazil, which is among the five countries with the largest area of forest, recent losses (from the year 2010 to 2015) reached 984,000 ha. Subtropical and tropical forests are the most affected type of forest, when compared with boreal and temperate systems (FAO 2015). In the Mediterranean region, the forested area is estimated to be 85 Mha (2 % of the world's forest area), however, this is unevenly distributed between countries. Of this, approximately 1.67 million ha is a primary forest (FAO 2010).

Despite these worrying values, forest management is quite different when comparing between Nordic countries, with an annual net forest gained since the year 1990, with those countries from the South Pole (FAO 2015). Apparently, Mediterranean forests witnessed a spatial expansion of about 1 %, but in contrast, native forest and biodiversity is declining (FAO 2012). Many other examples of native forest/biodiversity loss worldwide may be assessed in current literature (Abood et al. 2015; Baltzer et al. 2014; Butchart et al. 2010; Ferreira et al. 2015; Miranda et al. 2015).

3.1 The Easter Island as an Example of Human Unsustainable Practices

The Easter Island situated in the Pacific Ocean (Eastern Polynesia) was a subtropical forest covered by palm trees, before the arrival of Polynesian people, approximately, in the 4th century (Kirch and Ellison 1994). Other evidences suggested a later arrival (Hunt and Lipo 2006). This forest was completely devastated by the Rapa Nui, and together with the concomitant erosion of primeval soils, practically caused its extinction.

If we continue to destroy forests at this rate, it is estimated that before the end of this century, the planet, will virtually have no forests. It will be transformed into an "island" without forests, as what happened in Easter Island.

John Dransfield discovered that the most abundant palm tree that existed in the Easter Island was extremely similar (or perhaps the same species) to the palm tree of Chile (*Jubaea chilensis*), that once had a vast spatial distribution and currently, only occurs in a strictly central area of Chile (between 32 and 35°S) (González 1998). Its fruit is highly appreciated for the purpose of eating and for extracting oil. From its elaborated sap, they produce an alcoholic drink, which is also very valued

by the Chilean people. The removal of the sap produced by incision is made on top of the stipe, which causes it to stop producing viable fruit and, most of the time, the tree dies. According to the International Union for Conservation of Nature [IUCN], it is classified as a vulnerable species (González 1998).

Despite already extinct in the subtropical forest of this island this native palm tree was classified as a new species to science: *Paschalococos disperta* (Zizka 1991) which probably became extinct due to the overexploitation of these palm populations. Not only was the respective fruit edible, it was used for many other purposes as well (they eat the heart of palm, used the wood for boats, probably produced an alcohol drink, and used the leaves to cover their houses). These and other unsustainable uses of the species and the services provided to the population, almost led to the extinction of the local population.

This example is a model of human-induced environmental degradation and illustrates very well what may happen to our planet if we continue to foster deforestation practices and devalue forest biodiversity and its services. Forests are the largest producers of biomass, with an extraordinary capacity to depollute (through the amount of carbon dioxide (CO_2) consumed) and behave as enormous natural factories of oxygen (O_2). Continuing with the present models of development, human population will not survive and the land will be a universal "island", deforested and uninhabited.

4 The Relevance of Biological Resources: From Basic Needs to Economic Development

Everyone knows that he/she needs to eat in order to live and grow, and that the food consists of biological materials (plants, animals, and other organisms). It is also known that, for any engine to work, it needs a fuel that, through exothermic chemical reactions (combustion) releases enough heat (energy) for the engine to operate. The fuels (for example, gasoline, diesel, alcohol, gas) are organic compounds with carbon (C), hydrogen (H_2) and O_2. When a chemical reaction occurs, CO_2 is expelled into the atmosphere.

Making an analogy with this example, we may look at our body as a group of several "engines". If the heart, lungs, brain, for example, stops working, the body as a whole also stops. These biological engines also need "fuel" to work. This fuel (food/nutrients) comes from plant products, livestock, and other living sources (yeasts, for example) which are then transformed into energy (heat), through exothermic reactions (digestion), similar to the combustion referred above. Food is the source of the combustible substances, C, H_2, O_2, and other elements crucial for our survival [for example Nitrogen (N)].

All living beings need nutrients to survive (consumers). The plants (producers), however, are able to synthesize their own food by taking sunlight, to generate endothermic chemical reactions (photosynthesis) with the help of CO_2 and water, present in the atmosphere. The plants therefore, produce biomass. Humans, like any

other animal, need to consume plants and other consumers in order to produce their own energy.

In addition to these basic services, other services provided by forests and biological resources are well known, clearly described in the Millennium Ecosystem Assessment [MEA] report (2003) and other work studies (Barbeta et al. 2015; Baró et al. 2014; Thompson et al. 2014). Despite the direct link, biodiversity and ecosystem services need to be better studied and understood (Balvanera et al. 2014).

Forests may be used to effectively generate other services, such as income, and employment. They are important systems for socioeconomic and political development. These systems play important roles in the society such as providing land for agriculture; timber and non-timber products, environmental services (for example, to regulate local, regional and global climate, store carbon, and purify air and fresh water), and employment (contributing to poverty alleviation) (Azul et al. 2009, 2014; Sunderlin et al. 2005; Verkerk et al. 2015). Indirect services may also be of benefit to the various stakeholders who depend on these systems (Azul et al. 2014; Duarte et al. 2013).

A new paradigm in forest exploitation is growing and, in addition to having more knowledge about the ecological functions (Barbeta et al. 2015), investment in exploring endogenous resources (non-timber products) and research on bioactive compounds are examples of new key ways that contribute to local, regional, and national socioeconomic activities (Azul et al. 2014). Integrating people in intelligent research and management of native resources, forests, and biodiversity are, thus, essential in forest exploitation and conservation of biological resources. The interest in buying green, natural, and native products is increasing. Environmental concern is pulling the investment in biotechnology and bio-industry as an emerging economy that may reverse the trends in the loss of forests and biodiversity as well as ensure the ecosystem's resilience (Azul et al. 2014; Pizarro-Tobías et al. 2015; Kingston 2010).

5 Biodiversity Unknown

From all our heritages (material, cultural, and biological), the only one essential to our survival, is the biological heritage (biodiversity), which has received less attention. In addition, the majority of our biological diversity is not yet known. From the almost 4 million species listed, including oceans, a large part is not sufficiently studied. At the end of the last century, the American biologist, Erwin (1982) after several studies in tropical rain forests (*pluvisilva*) of Central and South America, has calculated it could be as many as 30 million Arthropod species worldwide, and not 1.5 million as estimated at the time. It may be assumed that not even 10 % of the global biological diversity is known. The kingdom Fungi represent another example in which estimations increased from 0.5 to 10 million (Bass and Richards 2011; Blackwell 2011) over the last two decades. Every year, several new species are descried all over the world (see some recent examples on Table 1).

Table 1 Examples of macro-species discovered in the 20th and 21st centuries

Organism	Species	Year of description	Common name	Local	Reference
Animals	*Muntiacus vuquangensis*	1994	Giant Muntjac	Vietnam	Tuoc et al. (1994)
	Muntiacus puhoatensis	1997	Puhoat Muntjac	Vietnam	Chau (1997)
	Muntiacus truongsonensis	1998	Truong Son Muntjac	Vietnam	Giao et al. (1998)
	Muntiacus putaoensis	1999	Leaf Muntjac	Myanmar	Amato et al. (1999)
	Callicebus bernhardi	2002	Prince Bernhard's Titi Monkey	Brazil	Van Roosmalen et al. (2002)
	Callicebus stephennashi	2002	Stephen Nash's Titi Monkey	Brazil	
	Lophocebus kipunji	2005	Kipunji	Tanzania	Jones et al. (2005)
	Diopatra micrura	2010	–	Portugal	Pires et al. (2010)
	Rhinopithecus strykeri	2011	Myanmar Snub-nosed Monkey	Myanmar	Geissmann et al. (2011)
	Squamatinia algharbica	2012	–	Portugal	Reboleira et al. (2012)
	Nactus kunan	2012	–	Papua New Guinea	Zug and Fisher (2012)
	Crocidura fingui	2015	Shrew-Fingui	Island of Principe	Ceríaco et al. (2015)
Plants	*Wollemia nobilis*	1995	Wollemi Pine	Australia	Jones et al. (1995)
	Labramia mayottensis	1997	–	Comoro Islands	Labat et al. (1997)
	Arabis beirana	2001	–	Portugal	Silveira et al. (2001)
	Zygodon catarinoi	2006	–	Portugal	Garcia et al. (2006)
	Narcissus x *caramulensis*	2007	–	Portugal	Ribeiro et al. (2007)
	Tahina spectabilis	2008	Tahina Palm	Madagascar	Dransfield et al. (2008)
	Dendroceros paivae	2012	–	São Tomé e Príncipe Island	Garcia et al. (2012)
	Stachys caroliniana	2014	Hedge-nettle	USA	Nelson and Rayner (2014)
Fungi	*Psilocybe germanica*	2015	–	Germany	Gartz and Wiedemann (2015)

(continued)

Table 1 (continued)

Organism	Species	Year of description	Common name	Local	Reference
	Phallus drewesii	2015	–	São Tomé Island	Desjardin and Perry (2015)
	Inocybe praetervisoides	2015	–	Mediterranean region	Esteve-Raventós et al. (2015)
	Mutinus albotruncatus	2015	–	Brazil	da Silva et al. (2015)
Macroalgae	*Fucus guiryi*	2011	Seaweed	Portugal	Zardi et al. (2011)
	Phymatolithon lusitanicum	2015	–	Portugal, Spain	Peña et al. (2015)

Fungi, habitat soil, water, and organisms, are major drivers of ecosystems life cycles.

Another example of an extremely high biodiversity of insects of *pluvisilva* was the work conducted by Wilson (1987). This myrmecologist collected in one Fabaceae tree in the forest of Peru, 43 species of ants, which was approximately, equal to the ant diversity throughout the United Kingdom. Not to mention the enormous group of fungi (Blackwell 2011), and microscopic beings, constantly being discovered by science, as bacteria (Albuquerque et al. 2014) or archaea (Albuquerque et al. 2012), invisible to the naked eye.

Generally, when people think about unknown diversity they almost associate it to organisms of small dimension. Nonetheless, this is not always the case. There is probably more unknown micro biodiversity, but new macrofauna and macroflora are also constantly being discovered. For animals, it may be cited, for example, the discovery in the year 1994 in the *pluvisilva* of Laos, the species *Muntiacus vuquangensis*, the Giant Muntjac, an antelope larger than a goat (Table 1). Since then, 3 more *Muntiacus* species have been discovered (Table 1). In total, 1/3 of all the known Muntjacs (12), were discovered at the end of the 20th century.

Already in the 21st century, were described, in the year 2002, in the Brazilian Amazon, two new species of apes (*Callicebus bernhardi* and *Callicebus stephennashi*) (Table 1). In the year 2005, a new species was seen in Africa (*Lophocebus kipunji*) (Table 1), which was already in danger of extinction in the mountains of Southern Tanzania. More recently, a new species of a shrew mouse (*Crocidura fingui*) endemic, was observed in the Island of Principe. Many other examples are presented in Table 1.

New techniques are available for researchers, as the use of DNA barcodes (Kress et al. 2015), are revolutionizing the methods of identification and increasingly new species are discovered each year.

6 The Extinction of Species

Why should we be concerned about the loss of biodiversity? For the first time, one single species (*Homo sapiens*) may cause mass extinction, triggering its own demise and the first cause of the loss of biodiversity is habitat loss, which is due to human activities. The majority of people believe that the only species that are vital for us are those that we currently use (for example, for cooking) and that other species do not present any significant value.

One of the most obvious examples of this indifference is what is happening with the rhino. The 5 species of rhinoceros [2 African: the white rhino (*Ceratotherium simum*) and the black rhino (*Diceros bicornis*), and 3 Asian: the Indian rhinoceros (*Rhinoceros unicornis*), the rhino of Java (*Rhinoceros sondaicus*) and the rhino of Sumatra (*Dicerorhinus sumatrensis*)] are endangered, mainly because of (prohibited) hunt practices to remove their front "horns", which supposedly have medicinal attributes (cancer and sexual impotence). They are also used as adornment pieces, similarly to what happens to elephants, particularly in Africa (*Loxodonta africana*). Despite the strict prohibition of the hunting of the rhino (and other species), even in Natural Parks, created for conservation purposes, illegal/legal hunt creates new ways to bend the established rules of conservation. Who does not remember the killing of the Cecil lion, a major attraction of the Hwange National Park in Matabele land North, Zimbabwe? This shocking case broke out in the media and at least, served to draw the attention for this kind of practices that lead to the extinction of these type of animals.

This "folklore" of aphrodisiac attributes also occurs for other species. The coconut of Seychelles (*Lodoicea maldivica*), due to its anatomical form (Fig. 3), make people believe on its powerful aphrodisiac ability. Presently, it only exists in two islands and collecting the fruit is strictly prohibited. Another example of this stupid aphrodisiac panacea is the "Pau-de-Cabinda", family Rosaceae, *Prunus African* (*Pygeum africanum*), whose bark has chemical products (alkaloids) with some effect in the treatment of prostatic hyperplasia and contractile dysfunction. It is not, in fact, a good "aphrodisiac" and may cause death.

Living beings of greater volume (greater biomass)—plants—are also threatened by human practices. Some examples are the Californian (USA) sequoias (*Sequoia sempervirens*) (ca. 120 m height and 9 m in diameter), the Sierra Redwood (*Sequoiadendron giganteum*) (ca. 100 m height and 12 m in diameter and 2000 tonnes of biomass), and the American Poplar (*Populus tremuloides*) (ca. 6000 tonnes of biomass). The animal with the highest biomass is the blue-whale (*Balaenoptera musculus*). Larger animals of this species (35 m in length and 210 tonnes), were annihilated in the 20th century.

Plants are authentic factories of biomass and oxygen production and many authors consider the preservation of plant diversity as a prerequisite, not only for the maintenance of animals, but also for their evolution.

Fig. 3 Image of a coconut of *Lodoicea maldivica*

There are still many examples which oblige us to act in order to preserve all species without distinction, because, as it has already been mentioned, not all species are sufficiently studied.

In the Plant Kingdom, a good example is the species *Taxus baccata*, a rare species believed not to have any usefulness. It was a relatively common tree in the Mediterranean forests, which grows at very slow rates, It is an extremely poisonous plant, because it produces a mixture of alkaloids (taxine), lethal for all animals, and is used by populations since remote times (wood, bows and arrows, ornamental gardens, churches and cemeteries, as abortive, killing many times the foetus and also the mother, and even for suicide purposes). However, in the year 1993 (Guenard et al. 1993), it was proved to be of inestimable value. From the American *Taxus brevifolia*, it was isolated the taxol. This compound is an inhibitor of mitosis, by increasing the polymerization of tubulin, with the consequent stabilization of microtubules which prevents nuclear and cellular divisions. Unfortunately, a centenary *Taxus* tree provides only 300 mg of taxol, being necessary the bark of 6 centenarian trees to produce enough taxol to treat one patient. Fortunately, in the month of February 1994, the semi-lab synthesis of the substance was announced (Holton et al. 1994). Therefore, if *Taxus* had been extinct, this substance would never have been found.

In the animal kingdom, we present the case of the lizard *Heloderma suspectum*, the Gila Monster, native of south west of the United States and north of Mexico, that pastors killed whenever they visualized an individual, because it killed their animals (causing hypoglycaemia). The saliva of the lizard contains a protein

(exendin-4) which stimulates the pancreas to produce insulin. Since the year 2009, a medicinal product is authorised for diabetes type 2, that is, the synthetic version of exendin-4 (exenatide). Currently, it is prohibited to collect this species of lizard.

7 Conclusion

The well-being of mankind is directly connected to the way we treat the biological resources of our planet. Strategies to prevent deforestation, the extinction of species and habitats, pollution, and loss of biological diversity embody a major paradigm to societies, including the scientific community. Our consumerist society must take into consideration, the choice of more environmentally friendly goods, services, and economic activities. Together with public authorities, managers, scientists, land owners, and other stakeholders, new holistic management actions must be developed.

The conservation of our biological resources is crucial, due to the known services provided for human survival, but also encloses other services that we still cannot diagnose. New species are always being discovered and who knows what we may find. Without the biological heritage there is no food, medicinal drugs, energy, and other services. Therefore, we must assume the commitment to change our behaviour towards the sustainability of the ecosystems, because without biodiversity we will endanger the survival of our very own species.

References

Abood, S. A., Lee, J. S. H., Burivalova, Z., Garcia-Ulloa, J., & Koh, L. P. (2015). Relative contributions of the logging, fiber, oil palm, and mining industries to forest loss in Indonesia. *Conservation Letters, 8*(1), 58–67.

Alberti, M. (2015). Eco-evolutionary dynamics in an urbanizing planet. *Trends in Ecology & Evolution, 30*(2), 114–126.

Albuquerque, L., Johnson, M. M., Schumann, P., Rainey, F. A., & da Costa, M. S. (2014). Description of two new thermophilic species of the genus Rubrobacter, Rubrobacter calidifluminis sp. nov. and Rubrobacter naiadicus sp. nov., and emended description of the genus Rubrobacter and the species Rubrobacter bracarensis. *Systematic and Applied Microbiology, 37*(4), 235–243.

Albuquerque, L., Taborda, M., La Cono, V., Yakimov, M., & da Costa, M. S. (2012). Natrinema salaciae sp. nov., a halophilic archaeon isolated from the deep, hypersaline anoxic Lake Medee in the Eastern Mediterranean Sea. *Systematic and Applied Microbiology, 35*(6), 368–373.

Amato, G., Egan, M. G., & Rabinowitz, A. (1999). A new species of muntjac, *Muntiacus putaoensis* (Artiodactyla: Cervidae) from northern Myanmar. *Animal Conservation, 2*(01), 1–7.

Azul, A. M., Castro, P., Sousa, J. P., & Freitas, H. (2009). Diversity and fruiting patterns of ectomycorrhizal and saprobic fungi as indicators of land-use severity in managed woodlands dominated by *Quercus suber*-a case study from southern Portugal. *Canadian Journal of Forest Research, 39*(12), 2404–2417.

Azul, A. M., Nunes, J., Ferreira, I., Coelho, A. S., Veríssimo, P., Trovão, J., et al. (2014). Valuing native ectomycorrhizal fungi as a Mediterranean forestry component for sustainable and innovative solutions 1. *Botany, 92*(2), 161–171.

Baltzer, J. L., Veness, T., Chasmer, L. E., Sniderhan, A. E., & Quinton, W. L. (2014). Forests on thawing permafrost: fragmentation, edge effects, and net forest loss. *Global Change Biology, 20*(3), 824–834.

Balvanera, P., Siddique, I., Dee, L., Paquette, A., Isbell, F., Gonzalez, A., et al. (2014). Linking biodiversity and ecosystem services: current uncertainties and the necessary next steps. *BioScience, 64*(1), 49–57.

Barbeta, A., Mejía-Chang, M., Ogaya, R., Voltas, J., Dawson, T. E., & Peñuelas, J. (2015). The combined effects of a long-term experimental drought and an extreme drought on the use of plant-water sources in a Mediterranean forest. *Global Change Biology, 21*(3), 1213–1225.

Baró, F., Chaparro, L., Gómez-Baggethun, E., Langemeyer, J., Nowak, D. J., & Terradas, J. (2014). Contribution of ecosystem services to air quality and climate change mitigation policies: The case of urban forests in Barcelona, Spain. *Ambio, 43*(4), 466–479.

Barthlott, W., Hostert, A., Kier, G., Küper, W., Kreft, H., Mutke, J., et al. (2007). Geographic patterns of vascular plant diversity at continental to global scales (Geographische Muster der Gefäßpflanzenvielfalt im kontinentalen und globalen Maßstab). *Erdkunde*, *61*(4), 305–315.

Bass, D., & Richards, T. A. (2011). Three reasons to re-evaluate fungal diversity "on earth and in the ocean". *Fungal Biology Reviews, 25*, 159–164.

Blackwell, M. (2011). The fungi: 1, 2, 3, … 5.1 million species? *American Journal of Botany, 98*(3), 426–438.

Butchart, S. H., Walpole, M., Collen, B., Van Strien, A., Scharlemann, J. P., Almond, R. E., et al. (2010). Global biodiversity: Indicators of recent declines. *Science, 328*(5982), 1164–1168.

Ceríaco, L. M., Marques, M. P., Jacquet, F., Nicolas, V., Colyn, M., Denys, C., et al. (2015). Description of a new endemic species of shrew (Mammalia, Soricomorpha) from Príncipe Island (Gulf of Guinea). *Mammalia, 79*(3), 325–341.

Chau, B. (1997). Another new discovery in Vietnam. *Vietnam Economic News, 47*, 46–47.

Chen, Y., Li, X., Liu, X., & Ai, B. (2013). Analyzing land-cover change and corresponding impacts on carbon budget in a fast developing sub-tropical region by integrating MODIS and Landsat TM/ETM + images. *Applied Geography, 45*, 10–21.

Collen, B., Whitton, F., Dyer, E. E., Baillie, J. E., Cumberlidge, N., Darwall, W. R., et al. (2014). Global patterns of freshwater species diversity, threat and endemism. *Global Ecology and Biogeography, 23*(1), 40–51.

da Silva, B. D. B., Sousa, C. T., Martín, M. P., Marinho, P., Calonge, F. D., & Baseia, I. G. (2015). Mutinus albotruncatus (Phallales, Agaricomycetes), a new phalloid from the Brazilian semiarid, and a key to the world species. *Phytotaxa, 236*(3), 237.

Davidson, D. J., Andrews, J., & Pauly, D. (2014). The effort factor: Evaluating the increasing marginal impact of resource extraction over time. *Global Environmental Change, 25*, 63–68.

Desjardin, D. E., & Perry, B. A. (2015). A new species of Phallus from São Tomé, Africa. *Mycologia, 101*(4), 545–547.

Doney, S. C., Ruckelshaus, M., Duffy, J. E., Barry, J. P., Chan, F., English, C. A., et al. (2012). Climate change impacts on marine ecosystems. *Marine Science*, *4*.

Dransfield, J., Rakotoarinivo, M., Baker, W. J., Bayton, R. P., Fisher, J. B., Horn, J. W., et al. (2008). A new Coryphoid palm genus from Madagascar. *Botanical Journal of the Linnean Society, 156*(1), 79–91.

Duarte, G. V., Moura, A. I., Moreira, R., Nunes, J., Figueiredo, M. M., & Carvalho, M. G. (2013). Evaluation of several forest residues as potential raw material for bioethanol production in Portugal. *Journal of Bioprocess Engineering and Biorefinery, 2*(1), 73–78.

Erwin, T. L. (1982). Tropical forests: their richness in Coleoptera and other arthropod species. *Coleopterists Bulletin, 36*(1), 74–75.

Esteve-Raventós, F., Horcajada, G. M, Alvarado, P., & Ibarguren, I. O. (2015). Unraveling the *Inocybe praetervisa* group through type studies and ITS data: *I. praetervisoides s*p. nov. from the Mediterranean region. *Mycologia.*

European Environment Agency. (2010). *Assessing biodiversity in Europe (5/2010 report)*. Copenhagen: European Environment Agency.

European Environment Agency. (2015). *The European environment—State and outlook 2015: Synthesis report*. Copenhagen: European Environment Agency.

Ferreira, M. P., Alves, D. S., & Shimabukuro, Y. E. (2015). Forest dynamics and land-use transitions in the Brazilian Atlantic Forest: The case of sugarcane expansion. *Regional Environmental Change, 15*(2), 365–377.

Food and Agricultural Organization. (2010). *Global forest resources assessment, 2010. Main report*. FAO Forestry Paper 163. Rome, Italy: UN Food and Agriculture Organization.

Food and Agricultural Organization. (2012). *The state of the world's forests 2012*. Rome, Italy: UN Food and Agriculture Organization.

Food and Agriculture Organization. (2015). *Global forest resources assessment 2015*. Rome, Italy: UN Food and Agriculture Organization.

Garcia, C., Lara, F., Sérgio, C., Sim-Sim, M., Garilleti, R., & Mazimpaka, V. (2006). *Zygodon catarinoi* (Orthotrichaceae, Bryopsida), a new epiphytic species from the Western Mediterranean Basin. *Nova Hedwigia, 82*(1–2), 247–256.

Garcia, C., Sérgio, C., Villarreal, J. C., Sim-Sim, M., & Lara, F. (2012). The hornworts Dendroceros Nees and Megaceros Campb. in São Tomé e Príncipe (Africa, Gulf of Guinea) with the description of Dendroceros paivae sp. nov. *Cryptogamie, Bryologie*, *33*(1), 3–21.

Gartz, J., & Wiedemann, G. (2015). Discovery of a new caerulescent Psilocybe mushroom in Germany: *Psilocybe germanica* sp.nov. *Drug Testing and Analysis, 7*(9), 853–857.

Gaston, K. J. (2000). Global patterns in biodiversity. *Nature, 405*(6783), 220–227.

Geissmann, T., Lwin, N., Aung, S. S., Aung, T. N., Aung, Z. M., Hla, T. H., et al. (2011). A new species of snub-nosed monkey, genus Rhinopithecus Milne-Edwards, 1872 (Primates, Colobinae), from Northern Kachin state, Northeastern Myanmar. *American Journal of Primatology, 73*(1), 96–107.

Giao, P. M., Tuoc, D., Dung, V. V., Wikramanayake, E. D., Amato, G., Arctander, P., et al. (1998). Description of *Muntiacus truongsonensis*, a new species of muntjac (Artiodactyla: Muntiacidae) from central Vietnam, and implications for conservation. *Animal Conservation, 1*(01), 61–68.

Giljum, S., Hinterberger, F., Bruckner, M., Burger, E., Frühmann, J., Lutter, S., et al. (2009). O*verconsumption*? *Our use of the world's natural resources*. The Sustainable Europe Research Institute (SERI), GLOBAL 2000, Friends of the Earth Europe, Vienna. http://www.foeeurope.org/publications/2009/Overconsumption_Sep09.pdf

González, M. (1998). *Jubaea chilensis*. *The IUCN Red List of Threatened Species* 1998: e.T38586A10128158. Downloaded December 08, 2015. http://dx.doi.org/10.2305/IUCN.UK.1998.RLTS.T38586A10128158.en

Guenard, D., Gueritte-Voegelein, F., & Potier, P. (1993). Taxol and taxotere: discovery, chemistry, and structure-activity relationships. *Accounts of Chemical Research, 26*(4), 160–167.

Holton, R. A., Somoza, C., Kim, H.-B., Liang, F., Biediger, R. J., Boatman, P. D., et al. (1994). First total synthesis of taxol. 1. Functionalization of the B ring. *Journal of the American Chemical Society*, *116*(4), 1597–1598.

Hunt, T. L., & Lipo, C. P. (2006). Late colonization of Easter Island. *Science, 311*(5767), 1603–1606.

Jones, T., Ehardt, C. L., Butynski, T. M., Davenport, T. R., Mpunga, N. E., Machaga, S. J., et al. (2005). The highland mangabey *Lophocebus kipunji*: A new species of African monkey. *Science, 308*(5725), 1161–1164.

Jones, W. G., Hill, K. D., & Allen, J. M. (1995). *Wollemia nobilis*, a new living Australian genus and species in the Araucariaceae. *Telopea, 6*(2–3), 173–176.

Kier, G., Mutke, J., Dinerstein, E., Ricketts, T. H., Küper, W., Kreft, H., et al. (2005). Global patterns of plant diversity and floristic knowledge. *Journal of Biogeography, 32*(7), 1107–1116.

Kingston, D. G. (2010). Modern natural products drug discovery and its relevance to biodiversity conservation. *Journal of Natural Products, 74*(3), 496–511.

Kirch, P. V., & Ellison, J. (1994). Palaeoenvironmental evidence for human colonization of remote oceanic islands. *Antiquity, 68*(259), 310–321.

Kovanda, J., & Hak, T. (2011). Historical perspectives of material use in Czechoslovakia in 1855–2007. *Ecological Indicators, 11*, 1375–1384.

Kraft, N. J., Comita, L. S., Chase, J. M., Sanders, N. J., Swenson, N. G., Crist, T. O., et al. (2011). Disentangling the drivers of β diversity along latitudinal and elevational gradients. *Science, 333*(6050), 1755–1758.

Kress, W. J., García-Robledo, C., Uriarte, M., & Erickson, D. L. (2015). DNA barcodes for ecology, evolution, and conservation. *Trends in Ecology & Evolution, 30*(1), 25–35.

Labat, J. N., Pignal, M., & Pascal, O. (1997). Une nouvelle espèce de *Labramia* (Sapotaceae) de l'Ile de Mayotte dans l'Archipel des Comores. *Adansonia, 19*(2), 213–216.

Millennium Ecosystem Assessment. (2003). *Ecosystems and human well-being: A framework for assessment*. Washington, DC: World Resources Institute.

Miranda, A., Altamirano, A., Cayuela, L., Pincheira, F., & Lara, A. (2015). Different times, same story: Native forest loss and landscape homogenization in three physiographical areas of south-central of Chile. *Applied Geography, 60*, 20–28.

Nelson, J. B., & Rayner, D. A. (2014). New hedge-nettle (Stachys: Lamiaceae) from South Carolina, USA. *Journal of the Botanical Research Institute of Texas, 8*(2), 431–440.

Peña, V., Pardo, C., López, L., Carro, B., Hernandez-Kantun, J., Adey, W. H., et al. (2015). *Phymatolithon lusitanicum* sp. nov. (Hapalidiales, Rhodophyta): the third most abundant maerl-forming species in the Atlantic Iberian Peninsula. *Cryptogamie, Algologie, 36*(4), 1–31.

Pires, A., Paxton, H., Quintino, V., & Rodrigues, A. M. (2010). Diopatra (Annelida: Onuphidae) diversity in European waters with the description of *Diopatra micrura*, new species. *Zootaxa, 2395*(1), 17–33.

Pizarro-Tobías, P., Fernández, M., Niqui, J. L., Solano, J., Duque, E., Ramos, J. L., et al. (2015). Restoration of a Mediterranean forest after a fire: Bioremediation and rhizoremediation field-scale trial. *Microbial Biotechnology, 8*(1), 77–92.

Reboleira, A. S. P. S., Goncalves, F., Oromi, P., & Mendes, L. F. (2012). *Squamatinia algharbica* gen. n. sp. n., a remarkable new Coletiniinae silverfish (Zygentoma: Nicoletiidae) from caves in Southern Portugal. *Zootaxa, 3260*, 33–46.

Ribeiro, P. M., Paiva, J. A., & Freitas, H. (2007). *Narcissus* x *caramulensis* (Amaryllidaceae), a new hybrid for the portuguese flora. *Anales del Jardín Botánico de Madrid, 64*(1), 43–46.

Roll, U., Geffen, E., & Yom-Tov, Y. (2015). Linking vertebrate species richness to tree canopy height on a global scale. *Global Ecology and Biogeography,*. doi:10.1111/geb.12325.

Silveira, P., Paiva, J., & Samaniego, N. (2001). A new endemic species of Arabis L. (Cruciferae) from Central Portugal. *Botanical Journal of the Linnean Society, 135*(3), 299–303.

Sunderlin, W. D., Angelsen, A., Belcher, B., Burgers, P., Nasi, R., Santoso, L., et al. (2005). Livelihoods, forests, and conservation in developing countries: an overview. *World Development, 33*(9), 1383–1402.

Thompson, I. D., Okabe, K., Parrotta, J. A., Brockerhoff, E., Jactel, H., Forrester, D. I., et al. (2014). Biodiversity and ecosystem services: Lessons from nature to improve management of planted forests for REDD-plus. *Biodiversity and Conservation, 23*(10), 2613–2635.

Tuoc, D., Dung, V. V., Dawson, S., Arctander, P., & MacKinnon, J. (1994). Introduction of a new large mammal species in Vietnam. *Science and Technology News, 3*, 4–12.

United Nations, Department of Economic and Social Affairs, Population Division. (2015). *World population prospects: The 2015 revision, key findings and advance tables*. Working Paper N. º ESA/P/WP.241. New York, United Nations.

Van Roosmalen, M. G., Van Roosmalen, T., & Mittermeier, R. A. (2002). A taxonomic review of the titi monkeys, genus Callicebus Thomas, 1903, with the description of two new species, *Callicebus bernhardi* and *Callicebus stephennashi*, from Brazilian Amazonia. *Neotropical Primates*, *10*(suppl).

Verkerk, P. J., Levers, C., Kuemmerle, T., Lindner, M., Valbuena, R., Verburg, P. H., et al. (2015). Mapping wood production in European forests. *Forest Ecology and Management, 357*, 228–238.

Vitousek, P. M., Mooney, H. A., Lubchenco, J., & Melillo, J. M. (1997). Human domination of earth's ecosystems. *Science, 277*(5325), 494–499.

Wilson, E. O. (1987). The arboreal ant fauna of Peruvian Amazon forests: A first assessment. *Biotropica*, 245–251.

Zardi, G. I., Nicastro, K. R., Canovas, F., Ferreira Costa, J., Serrão, E. A., & Pearson, G. A. (2011). Adaptive traits are maintained on steep selective gradients despite gene flow and hybridization in the intertidal zone. *PloS one*, *6*(6), e19402–e19402.

Zizka, G. (1991). Flowering plants of Easter Island. *Palmarum Hortus Francofurtensis, 3*, 1–108.

Zug, G. R., & Fisher, R. N. (2012). A preliminary assessment of the *Nactus pelagicus* species group (Squamata: Gekkonidae) in New Guinea and a new species from the Admiralty Islands. *Zootaxa, 3257*, 22–37.