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Working Group 11

A New Bioeconomy of Forest Standing and Rivers Flowing

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Chapter 30: The New Bioeconomy in the Amazon - Opportunities and Challenges for a Healthy Standing Forest and Flowing Rivers

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ACCRONYMS AND ABBREVIATIONS

AAC	Annual Allowable Cut
AFS	Agroforestry Systems
BNDES	Brazilian Development Bank
CAMTA	Mixed Agricultural Cooperative of Tomé-Açu
CDB	Convention on Biological Diversity
CFM	Community-based Forest Management
CIFOR	Center for International Forestry Research
CONAB	Brazilian National Supply Company
ECLAC	United Nations Economic Commission for Latin America and the Caribbean
EMBRAPA	Brazilian Agricultural Research Corporation
ETS	Emissions Trading System
FDA	Food and Drug Administration
Fiocruz	Fundação Owaldo Cruz
GDP	Gross Domestic Product
GHG	Greenhouse Gas
HDI	Human Development Index
IBGE	Brazilian Institute of Geography and Statistics
ICMBio	Instituto Chico Mendes de Conservação da Biodiversidade

IDAM	Agricultural and Forestry Development of the State of Amazonas
ILK	Indigenous and local knowledge
ILPF	Integration of Crop, Livestock, Forest
IPLCs	Indigenous peoples and local communities
MDF	Medium Density Board
MPF	Federal Public Ministry
NGOs	Non-Governmental Organizations
TCOs	Communal Lands of Origin
UCs	Conservation Units
NUS	Neglected and Underutilized Species
PES	Payment for Environmental Services
PEVS	Production of Vegetable Extraction and Forestry
PNPSA	Brazilian National Policy for Payments for Environmental Services
REDD+	Reducing emissions from deforestation and forest degradation and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries
SAFTA	Tomé-Açu Agroforestry System
SAT	Traditional Agricultural Systems
SUS	Brazilian Unified Health Service
UEBT	Union for Ethical Biotrade

UNFCCC	United Nations Framework Convention on Climate Change
WWF	World Wide Fund for Nature

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KEY MESSAGES

- The Amazon is far from the scientific and technological frontier of the contemporary bioeconomy. The sustainable use of its socio-biodiversity is the main path for it to continue providing ecosystem services essential for life on the planet. At the same time, this offers opportunities to improve the living conditions of rural, forest, and urban populations, currently characterized by poverty, inequality, and threats to citizens' rights.
- Making forest socio-biodiversity the epicentre of sustainable economic development requires recognizing the importance of knowledge accumulated by forest peoples over millennia, as well as valuing current regenerative practices of increasing importance in the region.
- Bioeconomy is more than an economic sector. It synthesizes a set of ethical-normative values on the relationship between society and nature and their consequences. Bioeconomy has the ambition to guide social life towards the regenerative use of the biotic, material and energy resources on which we all depend. The opportunities that open up for combating poverty and inequality with the sustainable use of forest biodiversity are immense, not only in rural areas, but also in cities.
- The social and economic base for the sustainable use of standing forests and flowing rivers is broad and diverse. It involves traditional activities of forest peoples, family farming that is marked by land uses with rich biodiversity, and commodity agriculture focused on the production of grain and meat, which is beginning to face the challenge of also contributing to standing forests and flowing rivers.
- Growing global attention on forest devastation has mobilized diverse social and political forces in the Amazon in search of alternatives to predatory forms of development. International agreements, such as the Leticia Pact, stand out in this context, in addition to actions by subnational governments, coalitions of civil

society organizations, companies, scientists, and representatives of forest peoples to promote the transition to a knowledge economy for nature.

- One of the most important premises for the emergence of a new bioeconomy is to change the conception and forms of implementation of planned infrastructure projects. Meeting the population's basic needs, such as high-quality connections, agile transport services, and high-quality information to improve the commercialization of products, are basic objectives to which, in most cases, current infrastructure does not respond.
- The Amazon has several respected teaching and research organizations for science and technology. With appropriate institutional investments and international collaboration, a new bioeconomy of standing forests and flowing rivers can emerge.

ABSTRACT

In the past twenty years, bioeconomy has been increasingly recognized for its potential to create value and/or its contribution to sustainable development. Although most of the world's biodiversity is located in tropical regions, the main players and territories involved in the scientific and technological literature on bioeconomy are situated far from tropical forests. It is critical to understand, highlight and demonstrate the strategic role that forests in the Amazon can and should play in the global emergence of the bioeconomy. Evidences accumulate on the huge potential of these forests to increase the range of products and people well-being. This strategic role is not straightforward, as a result of the natural attributes of their ecosystems, but it has yet to be built. This construction goes through several fundamental elements, including: a) Recognition that, by ethical principles, strengthening the forest economy should support the improvement of local livelihoods; b) Institutional signaling against illegality and deforestation; c) Improvement in the quality of information about different products and their value chains; and d) Provoking the emergence of dynamic markets as alternatives to the incomplete, socially unfair and imperfect markets that today dominate the forest economy. This chapter paves the way for a new vision of a standing forest and river flowing bioeconomy. First, it exhibits bioeconomy as a recent field with no unified definition in international literature and presents the diversity of definitions available. After this, it presents the current state of a limited socio-bioeconomy of forest diversity in the Amazon. The low economic efficiency of current ways of using the forest is discussed and the current economic exploitation of forest socio-biodiversity are presented in three basic sectors: timber and non-timber products, and fishing. Later, the following services related to bioeconomy are presented: synergies with forest restoration, tourism, and payment for ecosystem services. Finally, it discusses the transition needed for standing forest and flowing rivers to become a vector for prosperity for its populations and the solutions for the global socioenvironmental challenges.

GRAPHICAL ABSTRACT

TBD

Chapter 30

1. INTRODUCTION

The starting point for stimulating the emergence of a strong and dynamic socio-biodiversity economy in the Amazon is the recognition that the most important tropical forest in the world has been occupied by people who knew how to make use of its gigantic wealth and contributed decisively to its maintenance for thousands of years. In the pre-Columbian period, eight million people lived in the Amazon, many of whom lived in villages that reached ten thousand habitants (Clement et al. 2015, see Chapters 8-10). These dense populational clusters had already been recorded in the sixteenth century, by Gaspar de Carvajal, a Dominican friar which accompanied Francisco de Orellana in his trip on the Amazon river (Plotkin, 2020:101).

The social activities of these peoples were not based on the destruction of the forest. On the contrary, they contributed decisively to what the ethnobotanist William Balée (2013) called "anthropogenic forest". Part of the current forest formation in the Amazon is a result from the management of various environments to "increase the abundance of plants used as food or fiber" (Plotkin, 2020: 102). Ethnobotanic studies in the twentieth century increased the knowledge not only of flora, fungi and the immense Amazon fauna, but also of their constant interaction with human populations (Schultes and von Reis, 1995).

Despite the violence against the Amazon's original peoples through the European colonization (see Chapter 9) and the prevalence of an economy based on the destruction of nature in the last fifty years (Hern, 1991, see also Chapters 14-20), the Amazon forest can still decisively contribute to solve some of the most relevant contemporary problems. This is due not only to the ecosystem services provided by the forest (Phillips et al., 2017), as its functioning as a carbon sync (Yang et al., 2018), but also due to its biodiversity (Fearnside, 1999) and the knowledge, techniques and economic practices of the peoples who inhabit it.

Today, this immense potential is underutilized (Vietmeyer, 2008) and is being systematically destroyed by forest devastation, by the growing aggression against forest dwellers and their territories, by an extractivism that scarcely benefits those who live in the region, and by a frequently low productivity agriculture/cattle ranching (see Chapters 14-20). Areas of expansion of the agricultural frontier (Garrett et al, 2017) have been associated with the degradation of fundamental ecosystem services on which human societies depend, starting with climate regulation, water supply and biodiversity. Amazon urban populations also do not benefit from land use practices that degrade its wealth and export the very results of this destruction to outside of the region (Costa and Brondizio, 2009). The prevailing infrastructures are currently aimed at making the Amazon a supplier of energy, minerals and agricultural commodities, based on ventures that promote benefits that are far from those who live in Amazon rural and urban areas (Chiavari et al, 2020; Antonaccio et al, 2020; Bebbington et al, 2020).

The fires that shocked the world in 2019, when São Paulo sky darkened in broad daylight (Setzer, 2019; Barlow et al. 2020) drew attention to the prevailing illegality and criminality in the region (Abdenur et al., 2020). These events drew attention mainly to the complacent attitude of several governments with destructive practices in the name of a supposed production of wealth supported by predatory practices, such as the invasion of Indigenous peoples' territories, the occupation of public areas or illegal mining. More than that, these fires highlighted one of the most important paradoxes of the 21st century: the distance from which the Amazon (as well as the other tropical forests) is from the scientific, technological and market frontier of contemporary bioeconomy. At the same time, the aggression against the forest and the people who currently inhabit it shed even more light on an indispensable challenge that needs to be overcame for a strong and dynamic bioeconomy in the Amazon: the transformation from current agriculture and livestock commodities in a sector that contributes to forest regeneration and to the offer of goods and services that are recognized by different markets as constructive for the strengthening of biodiversity. This orientation cannot be limited to forest areas. It must also reach the diversity of territory occupation modalities in the Amazon, which includes the commodities' production sector, wood production, forest regeneration and mining. As later discussed in this chapter, the experience coming both from farms that already use regenerative production methods and from hundreds of thousands of family farmers who enable their production through a rich polyculture, show an abundant and diffuse knowledge in the use of the forest. These current economic practices contain, albeit to a limited extent, precious lessons in the direction towards the sustainable development of rural areas in the Amazon.

1.1.An immense unrealized potential

The literature on the socio - biodiversity of the Amazon and on its territorial variety continues to grow, as shown by research programs, reports and conferences connected to the most important botanical gardens in the world, as well as by interdisciplinary research from the region, and from international universities and laboratories. The evidence that the destruction of the Amazon means the loss of valuable economic resources has been presented throughout the 20th century (e.g., Rodrigues et al. 2009).

In 1941, Celestino Pesce published “Oilseeds from the Amazon”, in which he studied variety native species. Many products of this biodiversity were processed locally and exported nationally and internationally. Pesce (1941) was an industrialist and, in 1913, bought a factory which had been closed for several years for processing ucuuba seed (*Virola surinamensis* (Rol.) Warb.). At the same time, he developed research that resulted in his book, whose preface insists on the scarcity of use of an extraordinary and unique wealth.

In 1979, Richard Evans Schultes published a text in which he praised the Amazon as a source of new economic plants. The article begins by mentioning those who regarded the Amazon as a “desert made of trees”, which needed to be removed. According to Schultes, this point of view was on the rise in the late 1970s. For him, on the contrary, there were countless reasons to preserve the Amazon. Climate change was not widely inserted yet on the agenda of international discussions at the time, and is not even mentioned in his article. Schultes (1979) proposes only one reason for the maintenance of the forest, a fundamental reason for the future of the human species: “its incalculable value as an unexplored emporium of germplasm for new economic plants”. Schultes demonstrates that the Amazon rainforest "should be considered as one of the most important origin centers of for cultivated plants", in contrast to the parsimony of the contribution of North America, Australia and most of Africa.

In his article, Schultes mentions the 1975 National Academy of Sciences report called "Underexploited Tropical Plants with Promising Economic Value". The report selects thirty-six species (out of more than 400) that should receive special attention because of their economic potential. One third of these were from the Amazon. It is interesting to note the connection that Schultes establishes between this diversity and forest dwellers: “Nowhere in the world”, he writes, “have native peoples used such a wide variety of plants in the preparation of products, such as arrow and ichthyotoxin poisons. And several ethnic groups have an extensive pharmacopoeia of presumed medicinal plants. The use of hallucinogens and other narcotics and stimulants is widespread. Everything points to the fact that the Amazon’s flora is a real, almost unlimited, chemical factory - and a chemical factory that is almost untouched, waiting for the attention of scientific research” (Schultes, 1979: 264).

In the aforementioned 1975 American report itself, the contrast between the potential of unexplored plants in tropical regions and its almost nil economic use is attributed to the concentration of research in some already consolidated plants (National Academy of Sciences, 1975). According to the report, there is a potential of products for industry, human and animal feeding, and chemical industries, that scientists are not studying. This is due partly to the scarcity of institutions in the world that trained people in tropical botany.

It is important to highlight the immense research effort located in the Amazon, in its various herbaria and research institutes, towards Amazon's biodiversity. The Amazonian Scientific Research Institute, for example, offers a database that includes an herbarium with 100,000 vascular and non-vascular plants, 8,200 species, of which 96 are threatened (Mendoza-Cifuentes et al. 2018). Its ichthyological and aquatic macroinvertebrate collections are also of great importance. Samuel Almeida, a researcher at the Museu

Paraense Emílio Goeldi, wrote “Plants of the Future of the Northern Region” and listed no less than 93 species about which there is a reasonable level of information (Vieira, et al, 2011). The book by Clay et al. (1999) is also an important example of scientific knowledge of Amazonian biodiversity. Research by the Brazilian Agricultural Research Corporation (EMBRAPA) shows that there are more than 250 species of palm trees in Brazil, more than half of which are located in the Amazon. However, research tends to prioritize approximately a dozen of these palm trees (Lopes et al., 2015).

The result is that even the contemporary pharmacopoeia is focused on the use of a small number of plants, which contrasts with the richness of global biodiversity. According to the 2017 Kew Royal Botanic Gardens report, less than 16% of the species used in plant-based medicine are officially regulated. The number of native plants in the Brazilian pharmacopoeia fell from 196 in the 1926 edition to 32 in 1959 and only four in 1997 (Allkin et al., 2017).

The contribution of the Amazon is insignificant, despite the work of several ethnobotanical museums in the region, such as the Sacata Museum, in Macapá (Brazil), which contains a Pharmacy of the Earth with raw materials produced by communities in the region. These initiatives, however, do not go beyond the strictly local scope. Currently, the only Amazonian product included in the Brazil Unified Health Service (SUS)’s list is “cat's claw” (*Uncaria tomentosa*), a species discovered by its use by Indigenous communities in Peru, and that has a wide distribution in all Amazonian countries (Valente 2006).

These are just a few examples that illustrate the paradoxical distance between the greatest socio-biodiversity on the planet and the scarcity of its main forms of use. It is clear that this deficiency cannot exclude the existence of an economy of forest socio-biodiversity throughout the entire Amazon, which has social and market structures that are part of the culinary, materials, religious rituals and therapeutical options of its populations, and which is strongly supported by the knowledge of Indigenous peoples and different local traditions.

However, the utilization of this wealth and the benefit it can bring to the forest dwellers, to the urban populations that are adjacent to them, and to the world, are far below their potential. In the meta-analysis published by Paletto et al. (2020:270), of the 225 documents on forest bioeconomy published by 567 organizations from forty-four countries, the most expressive countries in the area were Finland and Canada. Among the ten organizations that have published the most in the area of forest bioeconomy, there is none located in a country with tropical forests. Of all the works analyzed in the article (indexed by Scopus), the keywords "bioeconomy" and "tropical forests" never appear together. This does not mean the absence of research on the uses of biodiversity in tropical forests. Instead, it shows how distant this use is from what the literature and practices that give rise to products that rely on cutting-edge science and technology are from tropical forests.

The economic consequence of the inadequate use of the Amazon's forest biodiversity is well expressed in the work of Coslovsky (2021), referring to Brazil: between January 2017 and the end of 2019, the nine Brazilian Amazon states exported 955 different products. Of these, 64 agricultural or forestry products allowed an annual turnover of US$ 300 million. However, in the global market for these products, the participation of the Brazilian Amazon is negligible and does not reach 0.2% of the total. The Amazon is unable to compete with countries whose development indicators are more or less equivalent to its own, and occupies a negligible part of markets where, given its potential, its presence could be much greater (Coslovsky 2021).

In fact, the way of exploiting the Amazon's socio-biodiversity has remained practically the same since the colonial period. The oils from Andiroba (*Carapa guianensis* Aublet.; Souza et al., 2019) and Copaíba (*Copaifera* sp.), for example, are still conventionally extracted, generating low economic return. Nor is the wealth of fish in the Amazon subject to adequate industrialization and refrigeration, as further discussed below. One of the most important assumptions for the emergence of a new bioeconomy of standing forest and flowing rivers, is that it should be supported by an ambitious industrial policy that is based on the expansion of the socio-biodiversity knowledge, and that results in technological innovations that allow the benefit of Amazon populations through its elaboration processes, and of the entire world through its use. Without an industrial policy capable of stimulating entrepreneurial initiatives that surpass the current forms of production and use of forest and rivers products, there is no way to make biodiversity the decisive vector for the sustainable development of the Amazon.

The objective of this chapter is to suggest pathways for public policies and actions, both for business and civil society, in order to favor the emergence of a bioeconomy that contributes to raising the levels of human development in the Amazon, expanding the use of its biodiversity, exploiting its multiplier potential, stimulating infrastructures geared towards people's needs, and strengthening the scientific and technological knowledge necessary for the forest socio-biodiversity economy to become the epicenter of the region's development and an economic matrix that favors the expansion of socio-biodiverse areas.

These pathways are not limited to the sustainable economic use of what forest areas offer and can offer. It is paramount that the value chains that produce agricultural and mineral commodities transform their production techniques not only to eliminate forest destruction entirely, but also to have less impactful techniques and inputs on biodiversity within the production systems. Attention should be directed not only to forest dwellers, but to the thousands of family farmers in the region. Many of these are associated with conventional products from family farming (e.g., dairy products and cassava), and are often grown in a way that is compatible with a rich biodiversity production. One of the major obstacles to expanding this diversity is the instability of markets that are virtually interested in their products, and it is clear that a new bioeconomy of standing forest and flowing rivers will only have a chance to fulfill its vocation if it benefits Amazon urban populations. Strengthen urban markets where socio-biodiversity products are commercialized, stimulate companies aimed at the improvement and dissemination of this wealth, improve research that will allow the appearance of new products, and expand the potential of gastronomy linked to forest products, are some of the areas on which cities play a fundamental role in the emergence of a new, dynamic and competitive forest bioeconomy.

The emergence of a dynamic bioeconomy, that is capable of altering the institutional environment of economic practices that have contributed to the destruction of the Amazon, requires participation not only of the economic actors potentially interested in its use, but mainly the participation of the forest dwellers, family farmers, settlers and urban populations in the Amazon. It is paramount that the value chains that produce agricultural and mineral commodities are also transformed, in the sense that their activities contribute to forest conservation and regeneration, biodiversity strengthening, and that their production processes are tracked, allowing them to expose their products to markets that are connected to the general movement to protect ecosystem services offered by the Amazon to the world. There is currently an important example of soy and livestock chains tracking in the Amazon. The Trase platform has been contributing to the transparency of these chains, linking the impacts in the production regions with the global markets (Trase, 2021). It is also important that public, private or associative financial resources contribute to the objective of maintaining and regenerating the ecosystem services provided by the forest (through different forms of payment for environmental services - PES), and of favoring the sustainable use of biodiversity and knowledge from both science and the people who have contributed to keeping the forest standing.

This transformation must also be stimulated by the world of research and schooling. Bearing in mind the importance of improving livestock sustainability in the Amazon, for example, it is essential that researchers are familiar and committed not only to tracking techniques, but also to ways of using resources that encourage the integration among systems, as it is the case for the integration among crops, livestock and forest, that have already been happening in several initiatives in the region (Garrett et al. 2020). In the same way, it is necessary to stimulate research not only on the challenges represented by homogeneous plantations (e.g., eucalyptus or pine), but above all, of forest biodiversity regeneration. The examples can be multiplied given the urgency to fill the gaps in the taxonomy of plants and fungi and in the knowledge of the living wealth of biodiversity, in all strata of Amazon forests (from the floor to the canopy of the trees) (Plotkin, 2020).

This chapter is divided into seven sections, in addition to this introduction. Section two seeks to characterize bioeconomy as one of the most important values of contemporary socio-environmental thinking and, at the same time, its strategic value in supporting Latin America to occupy a relevant place on the frontier of global scientific and technological innovation. This section addresses some of the most established bioeconomy definitions. It is important to clarify that, given the characteristics of tropical forests, the option was to show bioeconomy as a highly diversified reality in terms of players, products and services, which is presented in section three. Section four describes the most important characteristics of the techniques and markets prevalent in the use of forest socio-biodiversity, focusing on timber and non-timber products, as well as in fisheries. Section five shows the importance and potential of three key services: forest regeneration, tourism and payment for environmental services. Section six analyzes the transition process from what has hitherto been an economy predominantly based on the destruction of nature to an economy of knowledge of nature, with an emphasis on the actors and some of the most important organizations involved in this transition. Section seven suggests some policies derived from this analysis, and section eight formulates the main conclusions of the chapter.

In addition to the bibliographic sources cited in the text, the chapter is based on a set of interviews with socio-environmental activists, entrepreneurs, scientists and several relevant actors in the emergence of a new bioeconomy of standing forests and flowing rivers.

2. BIOECONOMY: MORE THAN A SECTOR, AN ETHICAL IMPERATIVE

There is no consensual definition of bioeconomy. Thus, this chapter focused not on choosing a particular concept, but on presenting their diversity and highlighting guiding principles that should be followed. The report by the United States National Academies of Science, Engineering Medicine, when calculating that bioeconomy corresponds to 5.1% of the North American Gross domestic product (GDP), includes the agricultural sector as a whole, as well as the resulting technological gains of biotechnology (NASEM, 2020). The use of biological data towards medical accuracy, renewable obtaining of biomass focused on energy production, Biology Engineering, and synthetic biology, are some of the areas that contribute for the nearly US$ 1 trillion of bioeconomy to American wealth. Hence the definition of the report (p. 3) “The US bioeconomy is economic activity that is driven by research and innovation in the life sciences and biotechnology, and that is enabled by technological advances in engineering and in computing and information sciences”.

In the European Union, the link between the economic use of biological resources and the most important scientific achievements of the 21st century was also important in understanding bioeconomy as a strategic sector for economic growth (Birner, 2018).

Aguilar e Patermann (2020) emphasize two fundamental dimensions of contemporary bioeconomy. The first brings it closer to the pioneering work of the Romanian economist Georgescu-Roegen (Georgescu-Roegen 1977; Carpintero 2006), by insisting on the need for a holistic approach to the theme, and that goes beyond its sectoral dimension. According to this vision, it is the entire economic system which is transformed, and its development depends on the co-evolution between society and nature. Fücks (2015: 201) goes so far as to speak of a “mode of production powered by the sun”. There is an important line of contemporary thinkers, of whom René Passet, Herman Daly, Kenneth Boulding and Partha Dasgupta are among the most influential, whose work shows that economic activity depends on services provided to humanity by nature, and that the sustainable use of biodiversity has a decisive function (Boulding, 1966; Daly, 1996; Passet, 1996; Dasgupta, 2021).

The second dimension to which Aguilar e Patermann (2020) call attention, is that the destruction of biodiversity and at the same time, the scientific advances showing their immense potential to improve social life, give space for the emergence to a new relationship pattern between countries, that they do not hesitate to call biodiplomacy. This is not about challenging the sovereignty of each country over its respective territories and the legitimacy of conventional diplomacy, which turns primarily to the defense of national interests, but this defense does not overlap with a "global and integrated approach to the management of global challenges that affect the biosphere" (p. 24).

In European documents, discussions that precede the Convention on Biological Diversity (CBD), and the most prestigious academic production on the subject show that, much more than an economic sector, bioeconomy can and should be considered as an imperative of an ethical-normative nature, that is, as a value. Its economic importance is growing, but, at the same time, the clear European definition linking bioeconomy to the circular economy is a choice for the bioeconomy to be an essential component of the goal that in 2050 humanity will live in harmony with nature, to use CBD's expression (CBD, 2020).

In Latin America, many countries tend to assimilate part of the concepts adopted in European or North American literature. However, appropriate adaptations to the regional context need to be made, since bioeconomy initiatives are increasing and national bioeconomy policies are being developed (e.g., Sasson and Malpica 2017; Lopez-Hernandez and Schanz 2019), as will be seen below.

2.1 Why a new bioeconomy of standing forests and rivers flowing?

Addressing bioeconomy as a value in the case of tropical forests (and particularly the Amazon) means that economic activities, despite their wide variety of sectors, players and technical resources, must always result in the strengthen of forest socio-biodiversity and in the improvement of living conditions of rural and urban populations inhabiting in their territory. It is about uniting what has been, until now, separated: to improve the living conditions of its population (rural and urban) not through the destruction of nature, but through the knowledge about it.

The idea of a new bioeconomy of standing forest and flowing rivers is therefore not rhetorical. If it is true that contemporary bioeconomy will increasingly rely on ethical and normative precepts directed to transform, supported by science and technology, current destructive relations between society and nature, the fact is that the translation of this value into practice, when comes to tropical forests, is in its beginnings.

One of the most surprising findings from examining the scientific and technological literature on contemporary bioeconomy is the scarcity of references to tropical forests and the Amazon. As previously highlighted in this chapter, the publications on botanical economics in recent decades are fertile in pointing out the potential of the Amazon for bioeconomy. However, the precariousness of the practical implementation of this potential is shocking, when one takes into account that this is the territory with the greatest biodiversity on the planet. The vast literature on Neglected and Underutilized Species (NUS) (Padulosi et al., 2019, Antonelli et al., 2020) expresses well the gap between the richness of biodiversity and the precariousness of its economic use.

This chasm is explained, first of all, by the unprecedented character of the challenge represented by the sustainable use of the tropical forest, based on the knowledge economy, as already pointed out in an important document from the Brazilian Academy of Sciences in 2008 (ABC, 2008). In temperate countries, the bioeconomy is based on the strength of laboratories, in the use of planted crops or in very homogeneous forests. Bioenergy, biomaterials, resins, achievements derived from the use of digital technologies to obtain molecules that are useful in the production of medicines, new productive techniques that allow to reduce the use of pesticides and chemical fertilizers in agriculture, and new forms of animal feeding, are components of a contemporary bioeconomy that rise in environments whose biological diversity is much less complex than that of tropical forests.

Harnessing the potential of tropical forests without destroying them, converting their regeneration an economic growth engine, combining scientific knowledge to the knowledges from the forest dwellers, and transforming the production and commercialization of commodities in a way that they can be integrate into the strengthening of forest environments, are some of the most important challenges encountered by a new bioeconomy of standing forest and flowing rivers. Until now, overcoming this challenge in the Amazon has been unsatisfactory.

A recent survey on bioeconomy in the world shows that only Brazil, Colombia and Ecuador, among the countries of the Amazon, have bioeconomy policies (German Bioeconomy Council, 2018). Furthermore, as is clear from the recently released document by the National Confederation of Industry in Brazil, these policies convey no strategy for an economy of forest socio-biodiversity to emerge in the Amazon. Likewise, a recent publication on bioeconomy in Latin America and the Caribbean from the United Nations Economic Commission for Latin America and the Caribbean (ECLAC), cites the Amazon only once, and focuses on what the crops planted on the continent can offer (Rodríguez et al., 2019). In the important book organized by Lewandowski (2018) on bioeconomy, tropical forests are mentioned in only one item and there is only one quote about the Amazon.

The forest is recognized as a provider of ecosystem services, but not as a territory in which contemporary scientific and technological achievements in bioeconomy can represent a path for development. There is a gap between the richness of the forest and the current ways of utilizing it.

2.2 Bioeconomy: A path to scientific and technological innovation frontier

Filling this gap is not only a matter of interest only to those who live in the Amazon. A new bioeconomy of standing forests and flowing rivers offers a strategic pathway to bridge the gap that separates the Latin America today from the global scientific and technological innovation frontier (IDB, 2010). At the beginning of the 1980s, Latin America had a global competitive industrial expression. Since then, the continent has gone through a process of re-primarization of its economic life, which some authors do not hesitate to call neo-extractivism (Gudynas, 2021). The Atlas of Economic Complexity from Harvard University (Haussman et al., 2013) shows that the density of Latin America's insertion in the global economy is marked by a low incorporation of knowledge, information and intelligence. This is not to underestimate the importance of scientific and technological advances of Latin American agriculture - although these advances have been insignificant in the Amazon -, but these results are not sufficient to bring the continent closer to the global frontier of scientific and technological innovation. Perez (2015), one of the most important researchers on technological revolutions of the modern era, advocates for a pattern of economic growth supported by natural resources in Latin America. Her justification is that the prospects for the continent to assert itself as a significant exporter of televisions, automobiles or microchips are low, since it has accumulated a delay in those areas that will not be overcome in the short term. It is in its natural resources and - above all - in the systematic application of science and technology to sustainable exploration, processing and pharmaceutical discoveries embedded in biodiversity, that Latin America finds its greatest chances to move from an economy whose international insertion is based on commodities, towards a pattern in which forest biodiversity products, based on the knowledge economy, gain increasing national and international importance. In order to fulfil the ambition for the Amazon to become an important protagonist in the contemporary bioeconomy, this is the strategy that should be followed. However, for a new economy of standing forest and flowing rivers to emerge in the Amazon, it is necessary to, first of all, compile a summary of the main current characteristics of the economic use of forest socio-biodiversity. This is the theme of the next item of this chapter.

3. DIVERSITY, THE KEY FEATURE OF BIOECONOMY IN THE AMAZON

Diversity is the most important feature of the current forest socio-biodiversity economy in the Amazon. This trait does not only refer to the extraordinary and still highly unknown biological wealth of the region, but also to the variety of relations that the human populations that live in it establish with this biodiversity. First, it is important to notice that at least two thirds of Pan Amazon's inhabitants live in cities. At the same time, the organization of these urban centers does not correspond to the conventional image of cities, not only because of their inadequate infrastructure, but also because of their close relationship with the forest and with family farming areas. Furthermore, as discussed in section 7 of this chapter, countries as Brazil have a definition of urban population that depends much more on administrative definitions than on the reality of what a city is, which leads to a systematic underestimation of the demographic importance of the rural population.

In the occupation process of the Amazonian space, family farming (resulting from spontaneous migration, directed colonization or settlements) is also very important: in the Brazilian Amazon alone, there are 750 thousand family farmers. Although many incorporate an important part of the polyculture tradition typical of forestry populations into their productive practices, the need for income generation often leads these family farmers to expand their livestock areas, to the detriment of biodiversity (see Chapter 15).

Large farms also need to be considered, especially since land ownership concentration in the Amazon has been increasing in recent years, especially in Brazil (Romeiro et al. 2020). If it is true that there are examples of farms that seek to regenerate the forest area destroyed by their occupation, the fact is that in these large territorial units, deforestation is very high. Furthermore, the institutional degradation to which this deforestation is linked has violence generalization as a consequence: Sant'Anna and Young (2010) demonstrate that the homicide rate increases in the municipalities of the Brazilian Amazon with greater deforestation.

One of the richest analytical frameworks on bioeconomy in the Amazon was produced by a network of individuals, orgEnanizations and companies, which have been meeting regularly since the beginning of 2020, in an effort to develop proposals not only to stop violence and destruction, but also to address the emergence of a strong and competitive socio-biodiversity economy in the region. This initiative, called *Concertação pela Amazônia* ("Accord on the Amazon"), will be further discussed below. An important text produced by this organization (Concertação pela Amazônia, 2021) starts with an elementary, but decisive finding: the territorial extension, national traditions, different biomes, varied ethnic compositions, languages, and countries' legislations and institutions demand that the Amazon is always presented in its plurality. Diversity is the key feature, asset and challenge for the region.

Despite being developed within the scope of the Brazilian Amazon, the work of the *Concertação* is illustrative of a more general picture. Within the Amazon, there is the "conserved region" (where conserved forests are predominant), the "arc of deforestation" (presenting extensive open areas and few forest remnants, which in turn have already been degraded by logging and forest fires), an "Anthropized region of converted forest" (usually associated with areas opened by productive activities) and "cities". Each of these regions can be characterized by its predominant activity and also by a specific proposed development agenda.

Even the areas with a predominance of trees are diversified, as shown in Figure 30.1. This diversification ranges from conserved forest areas to native or exotic monocultures, passing through silvicultural enrichment of degraded forests, restoration of open areas and the planting of long-cycle exotic species.

[Figure 30.1 will be inserted here]

It is within the Amazonian diversity and its forest continuum that Concertação classifies the current bioeconomy on three fundamental types. These types are what can be truly defined as the bioeconomy of the Amazon, with a clear difference between this bioeconomy and that described in the international literature, which is not supported by such a rich and complex socio-biodiversity. It is important to notice that none of these types exist in a pure state and that they serve primarily as a heuristic resource to describe the socio-biodiversity that marks the current use of the forest.

First, there is the **traditional bioeconomy** based on the biodiversity of native ecosystems. Its predominant activities are of an extractivist nature, and are carried out for self-consumption, for commercialization with consolidated intermediaries (further discussed below), but also with unprecedented commercial circuits linked to fair trade. The productions derived from these activities hardly reach large volumes and only reach more dynamic markets as niche products. Exactly because of the biodiversity richness on which these activities are based, they may gain importance for the pharmacological, cosmetic and cutting-edge biotechnology segments. Strengthening businesses linked to this biodiversity is especially difficult not only due to the dependence of incomplete and imperfect markets in which its protagonists find themselves (further discussed below), but also to difficulties connected to legislations that regulate access to benefits obtained with the use biodiversity.

The second type is the **bioeconomy based on forest management**, which is suitable for regions where forests have undergone some type of disturbance or degradation (e.g., selective logging or fire) predominate. If in the previous type biodiversity is inherent to the activity, here the production systems can be more or less diverse. There is a great commitment from public and private organizations to implement Agroforestry Systems (AFS), including the Integration of Crop, Livestock, Forest - ILPF. In these regions, it is also important to plan priority areas to be restored for the recovery of relevant ecosystem services such as water and crop pollination.

The third type is the **commodities bioeconomy**. It may be surprising that agricultural and mineral commodities are included in a bioeconomy typological description, but this is justified for two reasons: 1) Due to the impacts (so far, almost always destructive) that these productions have on biodiversity; 2) Given the large area that commodity production currently occupies in the Amazon, it is urgent that the areas destined for them are also subjected to regenerative processes capable of making their high yields compatible with the protection and strengthening of biodiversity on its inside. This involves not only the conservation of forest areas within agricultural properties, but also techniques that reduce the use of chemical inputs in production, and that make use of forest resources for the emergence of productive systems intensive in knowledge, but not in chemical and pesticide fertilizers.

The challenge of a regenerative agriculture and livestock is not limited to large farms, but also involves family farming and the different associative forms of land-use in the Amazon. It is not uncommon, for example, that the production of small animals or freshwater fish is dependent on extensive grain cultivation, wasting an immense potential for inputs that could come from products undeveloped in the region itself. Agrarian systems in the planet's most biodiverse region cannot support its prosperity in techniques that threaten this biodiversity and do not make use of its potentials. This is the basic reason that justifies the ambition for the supply of commodities in the Amazon to be guided by the bioeconomy values examined in the item above.

The important thing is that the three segments are presented based on assets and, above all, on problems that need to be overcame for the emergence of a new bioeconomy of standing forest and flowing rivers. Moreover, precisely because it is a transition process, it is important to start with the understanding of the main expressions of the current economic use of the Amazon's socio-biodiversity.

Thus, in the next section, three activities' sectors are presented in a more detailed way, in order to underline some of the challenges offered in the Concertação analysis: timber, non-timber forest products and fishing/pisciculture. Commodities are not analyzed here, since their impacts have already been studied in previous chapters of this Report (see Chapters 14, 15 and 17). The important thing with regard to commodities is that they are one of the components of the emergence of a dynamic bioeconomy in the Amazon and, therefore, it is essential that they associate their productive capacities with the strengthening of biodiversity within the properties where they are developed.

Finally, socio-biodiversity strengthening must emerge within the scope of a circular bioeconomy. One of the most serious counterparts of the benefits linked to açaí economic success, for example (which will be examined below), is the multiplication of waste without proper destination. In Belém alone, in the State of Pará (Brazil), 16 thousand tons of this waste are produced daily. The Açaí Fruit Fiber Ecopanels proposal, supported by

IDESAM (2021) illustrates the fundamental link between the sustainable use of biodiversity products and the circular economy, as pointed out by Schroeder (2019).

4. THE CURRENT LIMITED ECONOMY OF FOREST SOCIO-BIODIVERSITY

The destruction of the largest tropical forest on the planet affects the Amazon as a whole, as seen in the previous chapters of this Report. In no country this destruction is more serious and threatening than in Brazil. The Brazilian Amazon accounts for 9% of the country's Gross Domestic Product (GDP; Amazônia Legal em Dados, 2021), but the deforestation in the region (classified as land-use change) contributed to 38% of the Brazilian greenhouse gas (GHG) emissions in 2019 (SEEG, 2020), being practically the only country the world who has approximately half of its emissions coming from land-use change (Damasio, 2020).

Given its size and diversity, it is important to notice that this predominance of destructive forms of use and occupation in the Amazon is not absolute. The demarcation of territories belonging to Indigenous, *quilombolas* and *ribeirinhos* peoples is a fundamental democratic achievement (Abramovay, 2020a). Deforestation rates inside Indigenous territories are two times smaller than they are outside of them in Colombia, 2.5 times smaller in Brazil, and 2.8 times smaller in Bolivia (Figure 30.2) (FAO and FILAC 2021).

[Figure 30.2 will be inserted here]

Territories held by Indigenous peoples and *quilombolas* contain one third of all carbon stored in forests in Latin America. The lands on which forest dwellers live on the continent contain more carbon than all forests in the Democratic Republic of Congo and Indonesia, the two countries with the largest forest areas in the world after Brazil (FAO and FILAC, 2021).

Some of these territories present a communitarian management of forest resources, as later discussed in this chapter. The exploration, in the interior of these territories, of non-timber forest products is also important, as shown by the results of Origens Brazil Seal, which paves the way for the sale of forest products based on fair trade principles (Origens Brasil, 2021).

Outside of Protected Areas, the collection of açaí (*Euterpe oleracea*), both in Bolivia and in Brazil, has consistently increased the income of dozens of thousands of families, having important multiplier effects on urban occupations (Costa, 2020). Study by Lopes et al. (2018) shows that, unlike the overwhelming majority of extractivist products, açaí is competitive when compared to cattle, for example. An important fraction of the product comes from areas endowed with rich biodiversity, inspired by the practices of traditional communities in the Amazon, as shown by the publications of Brondízio (2021), de Costa (2020) and Homma et al. (2006). Given the increase in Latin American and global demands, both the production value and the product supply have been increasing. Among the current products of Amazonian extraction and commercialization, açaí is certainly the one whose industrialization has advanced the most in the region itself. This advance refers not only to juice, but also to the clarified and lifilized açaí, in the form of oil or ice cream.

This is important to guarantee food safety, because the consumption of fresh açaí pulp contaminated by the protozoan *Tripanossome cruzi* has provoked outbreaks of Chagas disease in some cities in Pará, which can be prevented by processing açaí with sanitary techniques. However, further scientific research is needed to completely solve this issue.

Açaí also has anti-inflammatory properties (Machado et al 2019) and an immense potential for prostate cancer treatment (Jobim et al 2019). However, without an industrial policy aimed at long-term financing for these researches and that stimulates an environment in which innovative technologies are associated with their use, it is impossible for these potentials to be realized.

Figure 30.3. Açaí. Photo: Embrapa/Ronaldo Rosa.

In addition, as later discussed in section six of this chapter, the broad mobilization of the business sector is recent, but significant, especially in Brazil, with the goal of transforming the supply of agricultural commodities compatible with the strengthening of ecosystem services provided by the forest. Sambazon company has reached important markets in Europe and the United States, using a business model that articulates the demand for high nutritional organic products with the maintenance of ecosystem services in the forest (Tuncer and Schröder, 2010).

The recognition of these initiatives cannot, however, disguise the prevailing condition in the region, marked not only by technical precariousness, the almost complete absence of industrial processing of products, as well as frequent health-related obstacles that block its exports (Valli et al., 2018), but also by the dependence of the forest dwellers on incomplete and imperfect markets characterized by strong clientelist and personalized domination. Until the present days, the *aviamento* and the *regatão* remain as historical legacies that comprise the social framework of forest products, and express the difficulty for these products to give way to a strong and competitive bioeconomy of standing forests and flowing rivers. *Aviamento* is a system in which workers' debts to those who provide them with basic subsistence goods end up in forms of personalized dependency that can lead to slavery (Guillen, 2007), while *regatão* is a traveling trading system that transports goods from cities to the countryside, also buying products from forest populations (McGrath, 1999).

What is at stake here is not only the permanent tax evasion in which these economic activities take place, but above all the fact that they stimulate a market structure that does not favor quality, supply regularity and, much less, innovation. One of the premises of this commercialization system of biodiversity products is the challenge to obtain information about their prices. The sale of products from extractivist activity and the purchase of products needed by producers is frequently conducted among thew same players, establishing systems rooted on customized and clientelist domination.

4.1. Timber/wood

The tropical timber market in the Brazilian Amazon has been sharply reduced in the past two decades. From a production of 10.8 million cubic meters in 1998, the supply of native wood decreased to 6.2 million m^3 in 2018. Similarly to other extractive products (e.g., rubber), wood of Amazonian origin is being replaced by products such as wood from forestry monocultures, plastic, steel and aluminum, in civil construction, as shown by a recent study from Lentini and Vieira (2020).

IMAFLORA's Timberflow research program shows that the forestry sector has depleted the capacity for wood extraction in the Arc of Deforestation, which has given way to a new geography of forestry activity in the Brazilian Amazon. This displacement pattern "occurred because the forestry industry in the Amazon remains essentially the same with regard to the continued need to explore new forests to guarantee its long-term survival, due to the slow progress observed in the adoption of large-scale forest management" (Lentini and Vieira, 2020).

The processing of wood extracted in the Amazon is also inneficient. Wood processing reaches only 41% of what is extracted. And of this total processed, 72% corresponds to sawn wood, with low added value (Gomes et al. 2012). The furniture industry, the sector with the highest added value in the Amazon, has been losing competitive capacity in terms of number of companies, jobs or participation in exports.

This extractive and predatory model is consistent with the illegality that dominates the sector and that can overcome legally sold Amazon wood by the ratio of seven to one. Legal and sustainable exploitation can hardly compete with what Bryant et al. (1997) call "forest mining". Illegality also marks logging in Peru, as shown in a study conducted by the Center for International Forestry Research – CIFOR, providing a detailed description of its main techniques (Mejía et al., 2015).

The predominance of illegality and unsustainable techniques is not explained by the lack of knowledges regarding the sustainable management of tropical wood. These knowledges currently exist, and there are many communities that apply them correctly. Proper forest management consists of removing from the forest only what is estimated to be recovered over a given period (the Brazilian legislation recommends thirty-five years). In addition, it is necessary to calculate how much can be extracted (and removed from the forest, which involves detailed logistics) so that, a few decades later, regeneration can take place. If in the 1990s research on these techniques was in their infancy, today they have matured and are being applied (EMBRAPA, 2021) appropriately by several forest communities in Latin America, as a result of projects developed by EMBRAPA (Santos et al. 2021), as well as by organizations such as IMAZON and the Instituto Floresta Tropical (IFT, 2021).

In any case, studies accumulate evidence that forest policies in different countries need to be reassessed. The use of a few dozen species and the current management norms (cycle length, harvest intensity) prevent the recovery of wood stocks and, ultimately, the sustainability of the timber sector (Piponiot et al. 2019). Therefore, the development of bioeconomy in the wood sector involves *inter-alia* expanding the range of managed species, adapting management regulations and modernizing industrial processes, in order to allow the full regeneration of forests.

Given the current scenario, in which the demand for wood from tropical forests is declining (and here it is important to note that production from planted forests corresponds to approximately 90% of the wood supply in Brazil, according to IBGE; Schmid, 2019), and technical knowledge supported by solid scientific research is being amplified, this is a sector in which the forest socio-biodiversity economy could provide income and quality occupation on a considerable scale.

One of the main challenges is explained by the lower costs associated to illegal exploitation in comparison to those corresponding to technically advanced units, which respect environmental and labor laws. In addition, the lack of definition of property rights discourages long-term sustainable projects. The precariousness of management in the illegal exploitation of wood and in the technologies used in the process also prevents the adequate selective removal of wood, and leads to large-scale destruction (Brancalion et al., 2018). The contrast between this and the more advanced contemporary forms of management (and whose costs tend to reduce) is striking. Global initiatives such as the smart tree grid, which uses digital devices to scan millions of trees and detect key information to assess their resilience, are important in this aspect (Peskett 2020).

In addition, our interviews with individuals from this sector show that legislation enforcement ends up blocking constructive initiatives and further widening the distance between the costs of legal activities, when compared to predatory ones. Finally, the added value of timber production in the Amazon has regressed over the past 20 years. The volume of raw sawn wood increased 20% between 1998 and 2018, while products with higher added value – e.g., slabs, plywood - decreased by the same proportion (Lentini et al. 2020). It is also important to note that the wood species used today constitute a small part of the hundreds of species with potential in the region, resulting in underutilization of raw material and lost opportunities in the sector.

The adoption of technological innovations to increase efficiency in wood processing requires investment in fixed capital with a long maturity period. This only makes economic sense if there is a guarantee of long-term supply of wood in areas close to the processing units, which is antagonistic with the predatory extraction model traditionally practiced in the region that quickly depletes local reserves. As a consequence, there is little investment in technological improvement, as sawmills and processing units need to be mobile to move along the deforestation frontier. For this reason, guaranteeing land property rights, including public areas and Indigenous peoples and local communities (IPLCs) territories, is essential to ensuring long-term contracts for raw materials supply that make investment in the technological improvement of production viable, in addition to enabling forest certification, a necessary condition to reach buyer markets with greater added value (MacQueen et al. 2003).

Tropical forests have great potential in noble wood that forest plantations and the substitution of materials do not contemplate. There are basically two socially constructive ways to realize this potential.

The first is through the communitarian management by forest dwellers, which are the main holders of carbon stored in tropical forests, as previously explained. Approximately 35% of Latin American forests are in areas belonging to IPLCs, and these areas are the ones that most efficiently resisted deforestation on the continent (FAO and FILAC, 2020).

The surveillance of traditional communities, Indigenous or not, over their territories is essential to preserve forest stocks and, thus, guarantee long-term management. Ensuring land rights of these communities, including the demarcation of territories (extractive reserves, Indigenous territories, etc.), is economically beneficial, as local communities are the best park rangers because they are taking care of their own common good with various forms of collective management (Romanelli e Boschi, 2019).

Today, hundreds of communities generate income and jobs based on forest management. In some cases, their activities include the production of resins and other non-wood products, as well as tourism.

In Bolivia, 16 Communal Lands of Origin (TCOs) and ten Indigenous community lands held 111 approved Management Plans in 2013, totaling nearly 1.8 million hectares under forest management and an annual allowable cut (AAC) of over 800,000 m^3. According to AFIN (2014), about 300 000 m^3 (or 35%) of the AAC are harvested annually, generating about USD 7.5 million in gross income and benefiting around 6,000 Indigenous households (Del Gatto et al., 2018).

There is an additional opportunity to develop a sustainable bioeconomy based on the beauty and diversity of tropical hardwoods in Amazon forests. The transition zone between the Andean and Amazon forest biomes in Colombia, Ecuador, Peru and Bolivia (known as "*piedemonte*" or "*ceja de selva*") contains a very large diversity of the tropical hardwoods and timber species. Based on the highly probable assumption that wood products - especially those originating from tropical forests - will have their demand significantly increased in the next decades (ITTO, 2019), it is a safe bet to invest on large scale in agroforestry and forest enrichment systems which produce in a relatively short time (20-25 years) the best-quality hardwoods. And the beauty of the extensively tested agroforestry and forest enrichment arrangements in the Colombian Amazon region (Sist et al. 2021) is that they can be developed profitably and sustainably in areas already deforested or degraded. Hence, it is possible to combine sustainable and profitable timber with ecological restoration, reduction of forest fragmentation, and recovery of ecosystem services, in addition to maintaining forest biodiversity and ecotourism potential.

In addition to communal forest management, forest concessions are also an important path for the sustainable use of public areas, today threatened by invasions and land grabbing. Peru and Brazil are the countries in which these mechanisms have grown the most, although they are still far below their potential (Karsenty et al., 2008). Pereira et al. (2018) estimate that sustainable forest management has an annual extraction potential of between 2 and 7 million cubic meters of wood in forest concessions in the Brazilian Amazon, restricted only to Conservation Units specifically designated for this purpose (National Forests, State Forests for commercial exploitation, Extractive Reserves and Sustainable Development Reserves for communal exploitation).

The development of a strong forest socio-biodiversity economy based on the sustainable exploitation of wood faces four fundamental challenges. The first is linked to the predominant destructive forms of land use, with the opening of clandestine roads in Indigenous territories and protected areas: the effort to contain illegality through strict legal and administrative rules has inhibited economic initiatives aimed at legal and planned extraction of wood. The costs associated to legalized and sustainable operations restrict the competition with informal and criminal activities. The solution to this issue is not the relinquishment of clear rules for logging, but the repression of illegal activities through the production chain and at the same time, the formation of public and technical professionals capable of stimulating (and not restraining) legal activities related to forests.

The second challenge is to modify the dynamics of wood management, which is currently concentrated on the species with the highest commercial value, aiming to maximize profits until their local populations become extinct (Richardson and Peres, 2016). Mahogany (*Swietenia macrophylla*), rosewood (*Aniba rosaeodora*) and ipe (*Handroanthus* spp) are emblematic examples of highly valued wood species that became endangered or received trade regulation (IUCN, 2021; CITES, 2021). The balanced use of the hundreds of wood species across the spectrum of commercial value needs to be encouraged, which requires investment and innovation in harnessing, processing and adding value to these alternative species. Investments need to be channeled into the modernization of equipment, revenue and productive processes, as well as marketing for new species and products. The industrialization and commercialization of wood from monocultures of the native species paricá (*Schizolobium amazonicum*) is an example of high-quality production of reconstituted wood panels (Medium Density Board, or MDF) in Paragominas, Pará (FLORAPLAC, 2020).

However, there are serious problems both in terms of standardization in the cultivation of plants of this species (some individuals thicken, others remain stunted), and phytosanitary issues. Consequently, people involved in reforestation often prefer to use eucalyptus, an exotic species, over paricá, demonstrating the urgency for investments aimed at the domestication of native species for the development of forest restoration.

The third challenge is to connect logging with the demand for the product in the Amazon itself, through qualitative transformation. Various inputs for civil construction and shipping industry, for example, can be replaced by wood from the Amazon, as shown by the Center for Management and Strategic Studies (CGEE, 2009).

The fourth is forestry legislation itself, which presents a basic contradiction. On the one hand, its enforcement is deficient and fails to prevent the prevalent illegal practices. On the other hand, as shown by Hirakuri (2003), still valid for the present times, the administrative procedures for obtaining legal logging authorization are so complex that they end up discouraging the sustainable use of this resource.

4.2 Non-timber forest products

There are currently few products related to a forest socio-biodiversity economy represented by significant amounts in production, income and human occupation. Although the role of "non-timber forest products, including wild foods, forage, medicinal plants, construction material, fuelwood, and raw materials for handicrafts" is becoming increasingly recognized, their commercialization in a more professional way is still in its early stage, as shown by Meinhold and Darr (2019).

This situation highlights one of the most important challenges for the emergence of a new bioeconomy of standing forests and flowing rivers. On the one hand, it is essential to preserve and strengthen the attributes of forest and aquatic socio-biodiversity. At the same time, without the domestication and improvement of products such as cinchona (*Cinchona* sp.), Cacao (*Theobroma cacao* L.), cupuaçuzeiro (*Theobroma grandiflorum*), bacurizeiro (*Platonia insignis*), uxizeiro (*Endopleura uxi)* and so many others, the economic expression of biodiversity would be even smaller than it is today. One of main proposals of this chapter is the need to strengthen research aimed at making the attributes of forest and aquatic systems (ecosystem services derived from their socio-biodiversity) compatible with the domestication of species that may have economic expression and, therefore, contribute for income generation and productive patterns that are adapted to the local potentials of the Amazon, for the hundreds of thousands of farmers who live in the region.

What is at stake here is the multifunctional nature of rural spaces in the lands of family production, Indigenous peoples and local communities. The productive specialization of family farmers, for example, rarely promote monocultures, as is the case in other regions of the continent. In the Amazon, traditional practices that combine agricultural systems with extractivist management are widespread. In the Bailique Archipelago, located at the mouth of the Amazon River, for example, the açaí agroforestry production system was recognized as a good practice in Traditional Agricultural Systems (SAT), awarded by the Brazilian Development Bank (BNDES) in 2019. In this system, which is common in the estuarine floodplain region of the Amazon River, *açaizais* and swiddens are enriched with a diversity of annual or permanent crops, forming a mosaic of high value landscapes of agricultural, forest and aquaculture heritage (Euler et al. 2019). In its 2018 and 2019 editions, the SAT BNDES Award recognized 53 good practice initiatives for the safeguarding and dynamic conservation of SATs in the Brazilian territory, of which 16 are communities in the Amazon.

The work of research institutions regarding the knowledge and improvement of these diversified systems is essential. Agronomic research shows that the systems practiced by farmers are as important as the cultivars and the products with the highest yield potential, and, in a region like the Amazon, this combination of scientific and traditional methods is especially important. Even if there is a flag species (with more acceptance and market value), the system only exists based on an immense variety of plants. An interesting example is that of Oiapoque Indigenous communities that, given the appreciation of açaí in the markets, started to manage it, but did so (with EMBRAPA's support) using good practices and enriching their gardens with high-agronomic quality, pest-free banana and citrus seedlings. The result was an increase in production and supply by these communities to urban populations, both at fairs and by direct sales, of diversified Indigenous products (flour, gum, tapioca, pepper, tucupi, chicory, manioc, banana, cane, piquiá, lime, tucumã, cupuaçu, taperabá), in addition to açaí.

According to 'Production of Vegetable Extraction and Forestry' (PEVS) data (IBGE, 2019), Brazilian extractive production is strongly concentrated in the Amazon, and a great heterogeneity of contexts can be observed. Açaí stands out positively, with an increase in its production value from R$ 220.3 million in 2010 to R$ 539.8 million in 2016, reflecting that the increased demand for the product was compatible with the growth in supply capacity. And, as highlighted above, açaí ended up distributing wealth and enriching the multifunctionality of spaces, by associating its cultivation with a rich agricultural and forest diversity (Lopes et al. 2019).

The case of Brazil nuts goes in the opposite direction. The Brazil nuts is one of the three mostly recognized food products derived from extraction in the Amazon. Its value chain moves almost US$ 450 million globally. In Brazil, 60,000 extractivist families, organized in several small communal businesses, are responsible for the fact that the country is the largest producer in the world, with 33,000 tonnes/year (TRIDGE, 2020). Nevertheless, Brazil has been losing ground in the international trade of the product, which is now dominated by informality, as shown by an important document prepared in the context of the "Brazil's pro-chestnut dialogues" (Brazil, 2020a). In addition, the overwhelming majority of goods do not comply with basic technological and sanitary precepts, which means that Brazil nuts are on a special list of the European Union, due to the presence of aflatoxin. The consequence of informality is that Brazil (unlike Bolivia and Peru), inadequately benefits its product, which reduces its value.

Figure 30.4. Brazil nuts and seedlings in the background. Photo: Embrapa/Ronaldo Rosa.

In Bolivia, degrading forms of labor exploitation have marked the commercialization of nuts: both the “*habilito*” (advanced payment for work which in reality promotes a cyclical system of indebtedness of the worker with the *barraquero*) and the “*enganche*”, a type of debt slavery, are still frequent in the country. Gonzales Rocabado and Terán Valenzuela (2012), in a work for Conservation International, shows that the link between inadequate markets and degrading work is an “obstacle to improve and generate a positive social impact in the utilization of nuts”.

Guarana is an important symbol of the Amazon imaginary for Brazilians, as it is the source of one of the most popular soft drinks in the country. Although it is an Amazonian product, nowadays its production comes mainly from the State of Bahia. Two initiatives from research institutes in the State of Amazonas regarding this cultivation are worth mentioning. The first, from the Institute of Agricultural and Forestry Development of the State of Amazonas (IDAM), involves 200 communities in the municipality of Maués and 80 communities in the Saterê-Mawé Indigenous Reserve, using new technologies to increase the production and productivity (IDAM, 2019). The second comes from the Secretariat of Science and Technology of Amazonas, which together with other research institutions is executing the Inova SocioBio project, aimed at reducing the information asymmetry throughout the value chain in order to improve knowledge and strengthen the production chain of native guarana. *Warané* (native *guaraná*) and *waraná* bread (*guaraná* stick) received the first Geographical Indication (IS) granted to an Indigenous people in Brazil. It is worth mentioning that the native *guaraná* contains active ingredients and *guaraína* (caffeine from *guaraná*) in much greater proportions than the *guaraná* produced in Bahia (Algarve et al. 2019). These differentiations are part of what an industrial policy aimed at the sustainable valuation of socio-biodiversity should consider.

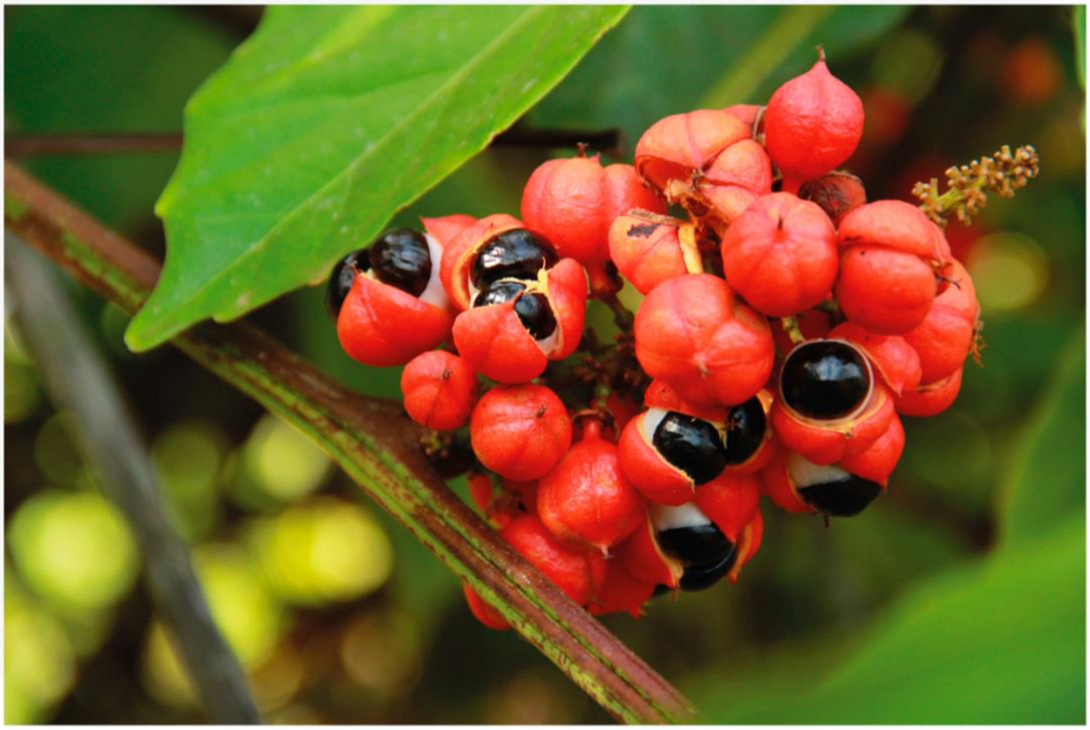

Figure 30.5. Guaraná in Altamira, Pará. Photo: Embrapa/Ronaldo Rosa.

The examples above show how fundamental it is to expand studies on Amazonian fruit trees (Shanley and Medina, 2005). In 1972, the first edition of the important book by Paulo Cavalcante (2010), already listed no less than 163 edible fruits in the Amazon, of which half corresponded to native fruit trees. Alfredo Homma (2016), when celebrating this diversity, laments "the scarcity of statistical data in relation to native and exotic fruit trees, vegetables and ornamental plants in the Amazon region ...". And he continues: "It is paradoxical to say that the apple is found even in the furthest corners of the Amazon and at a lower price than that of native fruits". Despite the region's gigantic biodiversity, no less than three quarters of the wholesale fruit and vegetable traded in Belém comes from other states in Brazil (Homma, 2016b). Nevertheless, it is not simple to harness this potential: most of these fruits rot quickly, are dispersed, and/or have multiple harvesting times and processing systems, which hinders their use on a large scale.

The extraction of natural rubber in the Amazon also shows a sharp decline: production fell by more than half between 2010 (4000 tons/year) and 2016 (1200 tons/year), and there was an even stronger reduction in the production value, falling from R$ 17.3 million to R$ 4.2 million in the same period (Pereira et al., 2018).

The market for vegetable oils derived from forest species in the Amazon is booming, and although official data does not yet reflect the real demand, they give an indication of the importance and economic impact of this productive activity, that has promoted diversification of forest production and of income sources for 45,751 extractivist families. Products such as andiroba seeds, babaçu coconut and almond, copaiba oil, cumarú seed, murumuru seed, ucuúba almonds, and tucumã fruits generated around R$ 50 million in raw materials sales (IBGE, 2019).

However, for the most part, these are technically limited productions, with low added value (Villa Nova, 2020) and whose capacity to generate income is compromised by the market structure in which they operate. As highlighted by Meinhold and Darr (2019), the value chains of these products rarely allow them to become the basis of a promising process of income generation. These chains are marked by "... limited market information available, poor infrastructure and financial constraints", and also by the fact that "… middlemen may sometimes be the only pathway for producers to access markets at all". Information asymmetry between buyers and sellers is the trademark of these value chains, which often results in prices below production costs. An econometric study conducted by Angelo et al. (2018) demonstrate low price elasticity in relation to demand, which is a clear sign of incomplete and imperfect markets.

The predominance of certain market structures in the Amazon are longstanding, in which the sellers of extractive products habitually depend on a single buyer, who is also the responsible for selling them the goods necessary for their subsistence. The extra-economic components involved in this relationship are very strong, as clearly described by Gonzales Rocabaldo and Terán Valenzuela (2012) when referring to the "*habilito*". In the second half of the 18th century, an "Amazonian *caboclo* peasantry" already existed, which articulated with the trade structure led by *regatões* (mobile merchants) and large '*aviadores*' (suppliers, financiers), and which connected the Amazon with the international drug market (Costa, 2020).

The predominance of these market structures over time is impressive. In an extensive work in the Northeast of the Brazilian Amazon, Meira (2018) formulates an important concept in the understanding of market structures in the Amazon: the persistence of *aviamento*. As previously mentioned, "*aviamento*" is a Portuguese word used to describe an economic and social relationship based on violence and on personalized dependence, which can even lead to slavery. This system has operated since the early colonization period and still persists, dragging a significant number of the local population, especially those who depend the most in the extraction of forest products, to an economic system based on personal relationships, intergenerational debts and modern slavery. Social and economic violence is at the base of this market structure.

In this context, the French geographer Pierre Gourou commented in 1948: "the wealthiest families owe their fortune to the control of the Amazon trade; they dominate the concentration in Belém and the export of everything that the Amazon sells; they have a monopoly on introducing what the Amazon buys. These suppliers (*aviadores*, original in the text) are often also colonels, that is, landowners, or more precisely, river owners". The commercialization of forest products in the first half of the 20th century was sustained by non-competitive markets, in which the buyers of the products were the same ones who sold to communities the staples they did not find in the forest itself.

This finding is important because it shows that, in fact, there is an economy of forest socio-biodiversity in the Amazon, but this is characterized by personalized forms of domination that are obstacles not only to competitive markets, but to innovative initiatives aimed at adding local value to what is extracted from the forest.

This process has been extensively described in the literature, but few quantitative data are available, even in current practices. The best described *aviamento* process was done by the Federal Public Ministry (MPF) in the state of Amazonas, Brazil, on the extraction and commercialization of piaçava and ornamental fish in the Rio Negro region of the Brazilian Amazon. There, MPF found modern slavery and an *aviamento* market structure in which non-monetary exchange and indebtedness were characteristic.

The result is that the "unfair distribution of income to extractivists and producers and their financial dependence on intermediaries and middlemen, the historical *aviadores*, have been part of local commercial relations for decades and constitute one of the most difficult paradigms to be broken" (Freitas and Schor, 2020).

This market structure, as synthesized by Conexsus (2020), is an obstacle for the countless cooperatives and associations existing in the interior of the Amazon to be able to "... identify the commercialization opportunities represented by the differentiated agricultural and extractive products that they produce". At the same time, companies virtually interested in these products are unaware of their immense variety and end up missing promising opportunities for new products. Most of the time, as shown by Conexsus' work, companies interested in biodiversity products end up buying them from intermediaries that compose value chains that discourage the emergence of dynamic and competitive markets.

Both the work from Brondizio and Conexsus show that non-timber forest products are extracted and commercialized by hundreds of individual producers and family networks, or groups organized in associations and small cooperatives. However, the function of these local organizations, in the overwhelming majority of cases, exhibits administrative and operational deficiencies (for example, to negotiate sales and export contracts, or to meet sanitary standards), as well as a lack of transportation, storage and processing infrastructure: they are informal, do not possess an accounting record of their operations, and depend on the incomplete and imperfect markets that characterize their social domination (Futemma et al., 2020; Brondizio, 2008). Of the 374 communal enterprises analyzed by Conexsus (2020), only 20% process/benefit products. In this context, it is clear that these initiatives do not have access to financing mechanisms capable of offering them the means to invest in improving their processing processes and working capital.

4.3 Fishing and Pisciculture

The Amazon Basin is a hotspot for aquatic biodiversity, with Amazonian fishes representing around 15% of all freshwater species described worldwide, with more than 3,000 species of fish cataloged (Tedesco et al., 2017; Leroy et al., 2019). Additionally, the Amazonian coast is part of the Amazon-Orinoco Influence Zone, considered an Ecologically or Biologically Significant Marine Area (EBSA) under the criteria defined by the Convention on Biological Diversity (CBD), including high biological productivity and biodiversity (CBD, 2014).

Fisheries have a major impact on food security and on local and regional economies in the Amazon. In certain areas of the lower Solimões River and upper Amazonas, it is the main source of protein for the resident human populations, although in urban regions fish is far from being the cheapest protein option.

In Brazil, fishing in the Amazon is classified into four subsectors discernable by different socioeconomic dynamics and sustainable management approaches. Subsistence fishing (for self-consumption), which represents up to 60% of the total produced, is noticeable by a great diversity of species. It is a dispersed activity, practiced by thousands of people and, therefore, its production is difficult to be quantified.

Commercial fishing is carried out across the entire Amazon basin and Amazonian coast, and supplies local and international markets. The composition of continental fisheries varies according to each specific region, with more than 90 species recorded on dockings, although around 80% of the production consists of only 6 to 12 species or group of species (Batista et al., 2012; Pinaya et al., 2016; Lima et al., 2017). In general, Characiformes and Siluriformes are the most relevant orders of fish (Zacarkim et al., 2015; Garcez et al., 2017), and the main fishing resources include: curimatã (*Prochilodus nigricans*), jaraquis (*Semaprochilodus insignis* and *S. taenirus*), tambaqui (*Colossoma macropomum*), dourada (*Brachyplatystoma rousseauxii*), filhote (*B. filamentosum*), mapará (*Hypophthalmus marginatus*), pacus (*Myleus* sp., *Metynnis* sp. and Mylossoma sp.) and surubins (*Pseudoplatystoma fasciatum* and *P. tigrinum*; Batista et al., 2012; Ruffino, 2014).

On the Amazon coast, fisheries include industrial and artisanal modalities. Industrial fisheries target piramutaba (*Brachyplatystoma vaillantii*), pargo(*Lutjanus purpureus*) and pink shrimp (*Penaeus subtilis* and *P. brasiliensis*), while artisanal fishing is multispecific, targeting mainly species of the order Perciformes and Siluriformes, such as pescada amarela (*Cynoscion acoupa*), pescadinha gó (*Macrodon ancylodon*), gurijuba (*Sciades parkeri*), uritinga (*S. proops*) and bandeirado (*B. bagre*), in addition to the manual capture of uçá crab (*Ucides cordatus*) (Jimenez et al., 2020; Isaac et al., 2009; Almeida et al., 2011). Another importante product for the international trade is swimming bladders (locally known as “grude”), a by-product extracted from pescadas and marine catfish, which is highly valued in China. Brazil is one of the main suppliers of “grude” to the Chinese market (Sadovy de Mitchelson et al., 2019) and more than 97% of Brazilian production comes from the Amazon coast (MDIC, 2021).

The main target of sport fishing are the tucunarés (*Cichla* spp.), but other species are also caught, such as traíra (*Hoplias malabaricus*), pacus (genera *Mylossoma*, *Myleus* and *Metynnis*), piranhas (*Serrasalmus* spp.), Corvina (*Micropogonias furnieri*), pescada branca (*Plagioscion squamosissimus*) and peescada amarela (*Cynoscion acoupa*) (Ruffino, 2014; Frédou et al., 2008).

In addition, there is fishing of ornamental species, with the capture of small fish for aquariums. Brazil and Colombia are responsible for most of the export of Amazonian ornamental fish, with the states of Pará and Amazonas being largely responsible for the export of fish coming from extractivist fishing (Tavares-Dias et al., 2009; Benzaken et al., 2015; Zehev et al., 2015). In the state of Pará, the trade of 400,000 ornamental fishes generates a revenue of nearly US$ 7 million per year, while in the state of Amazonas, which trades about 5,000,000 fishes, the revenue is approximately US$ 1.5 million per year (Faria et al., 2016). The main ornamental species explored in the Xingu River, an important area for this type of fishing in the state of Pará, belong to the Loricariidae family, including acari picota ouro (*Scobinancistrus aureatus*) - the most valued species -, acari amarelinho (*Baryancistrus xanthellus*), acari pão (*Hypancistrus* sp.), acari tigre da lista (*Peckoltia vittata*) and acari bola azul (*Spectracanthicus punctatissimus*) (Araújo et al., 2017). Ornamental fishing in this region supplies consumer markets in Brazil, the United States and Europe (Araújo et al., 2017).

Commercial fishing supplies mainly local and national markets, whose target species are the sea bream (*Brachyplatystoma rousseauxii*), piramutaba (*B. vaillantii*), piraíba (*B. filamentosum* Lichtenstein), surubins (*Pseudoplatystoma* spp.) and mapará (*Hypophthalmus marginatus* Valenciennes). Sport fishing has as the main species the peacock bass (*Cichla* spp.). Finally, the fishing of ornamental species captures mostly small popular fish to the aquarium trade, such as tetra cardeal (*Paracheirodon axelrodi*) - the most exported fish - and other species, as the neon green (*Paracheirodon simulans* Géry), rodóstomos (*Hemigrammus bleheri* Géry & Mahnart), rosaceu (*Hyphessobrycon* spp.), butterfly-fish (*Carnegiella* spp. and *Apistogramma* spp.) and rays (*Potamotrygon* spp.).

The pirarucu in Brazil and Colombia - or paiche in Peru (*Arapaima gigas*) is one of the emblematic Amazonian species. It is one of the largest freshwater fish in the world, widely distributed in the Amazon basin with occurrence records in Brazil, Peru, Colombia and Bolivia, and specimens commonly weighing from 125kg to 200kg. According to the Brazilian National Supply Company - CONAB (2020), there are 32 management areas in 19 municipalities in the state of Amazonas (Brazil), with fishing permits of 58,457 units/year, a 164% increase in pirarucu fishing permits from 2011 to 2018. The gross income provided by commercialization of pirarucu managed in these areas reached R$ 8 million, with a net income of around R$ 2,000/family. This value is significant if we consider that the average HDI (Human Development Index) of municipalities that produce pirarucu in Amazonas is equivalent to 0.541, and where the per capita monthly income of poor and extremely poor is below R$ 140.00 and R$ 70.00, respectively.

One of the main threats to fishery resources in this region is predatory fishing. It is common for fishing boats to throw away tonnes of fish, so that the specimens of the most valuable species can fit in the boat. The low participation of fishing communities in management and governance processes is also a serious problem, which ends up stimulating predatory practices that are responsible for the reduction of natural stocks and territorial conflicts between fishermen. In this sense, initiatives of communal fishery agreements aiming at the common use or shared management of certain lakes are important: in the State of Amazonas alone, there are about 70 recognized fisheries agreements, with emphasis on the Mamirauá project, whose results have stimulated the development of similar initiatives in several regions of the Pan Amazon (Queiroz and Peralta, 2006; Viana et al., 2007; Amaral 2009).

Another alarming threat is the contamination by heavy metals in regions where illegal mining takes place (see Chapter 21). A study from Fundação Owaldo Cruz (Fiocruz) in partnership with the World-Wide Fund for Nature (WWF-Brasil) in the Tapajós River basin showed mercury contamination by 100% of the examined Munduruku people, mainly due to the consumption of fish, the food base of the Indigenous and riverside communities in the region (Fiocruz and WWF, 2020). In a test with 88 fish species, all were contaminated with mercury. A similar study conducted by WWF-Brasil and ICMBio in Amapá state (2017) assessed the level of mercury contamination in fish species in and around the Tumucumaque National Park and the Amapá National Forest. Of the total animals sampled, 81% had mercury levels detected.

Similar to forest productive chains, the lack of infrastructure is a problem that inflicts difficulties and limits the expansion of this segment of the economy. The scarcity of ice factories, due to the energy limitations, ends up subjecting fishermen to local agents who have this equipment. The deficiency of storage and processing structures of post-catch fish, obliges fishermen who live far from consumer centers to sell their production at extremely low prices to brokers who carry out their products. This is aggravated by the fragile social organization of the fishermen, which hinders the battle for a fairer trade. In addition, there is a deficiency of technical assistance and access to adequate credit lines, since most of the existing lines were originally created to support agriculture and do not meet the particularities of fishermen (Jimenez et al., 2020).

The reduction in fish stocks has been boosting the production of fish in captivity in the Brazilian Amazon, which is also an important sector of the bioeconomy of the region in terms of income and food security. Fish farming has been tested in the Amazon in different ways, including artificial tanks, damming springs, closing segments of streams, floating cages and even restocking lakes and ponds. A species that receives a lot of attention is the tambaqui (*Colossoma macropomum*), with an annual production of 73,181 tons in 2019 (72% of the national production, moving BRL 535 million), followed by the pirarucu with 1,679 tons (88% of the national production, and BRL 21 million).

Despite this growth scenario, the current social and economic context has emphasized important bottlenecks in the sector, with production at the family level often being unfeasible. The high production costs of the rations that make captive farming uncompetitive, since fish from extractive fishing is cheaper and many consumers have a preference for fish from the natural environment. Also, the high cost and the low quality of the electric energy compromise the creation of juvenile fish, that depend on the oxygenation of the water. According to Christian Jesús Méndez, problems associated with fish farming in Peru and, by extension in South America, concern the low technological level in the entire production chain, ranging from ration production to the sale of fish; in addition, it is worth mentioning the limitations in business management processes, including the deficient associativism and business "clusters", and even the scarcity of sources of funding for technical-scientific investigations (INPA, 2018). Luiz Eugênio Conceição underlines some measures that can increase the possibilities of Amazonian fish farming, e.g., focusing on noble species with high nutritional value and good genetic load;

increasing the production volume to reduce transportation costs; promoting integration and partnerships among fish farmers; improving breeding, slaughter, transport and marketing conditions; caring for animal welfare and, consequently, improving meat quality; improving crop technology and water management; and boosting the development of certification processes to value products from fish farming (INPA, 2018). Promising results have been obtained with modern and more efficient techniques of salting, drying and freezing, as well as in adding value, transforming fish into burgers, smoked, crushed, breaded, marinated and surimi (Jesus et al., 1991). Technological treatment has also been applied in the transformation of fish skin into several products, from clothing to bags and wallets, as well as skins and bones in the production of collagen used in functional foods, cosmetics and nutraceuticals.

The use of fish processing residues from fisheries and aquaculture for the production of biogas, bio-jewelry, handicrafts, animal feed and food for human consumption (hamburgers, sausages, nuggets etc.), in addition to being a way of reducing environmental impacts caused by the inappropriate disposal of these materials, can be an income alternative in the post-capture sector (Jimenez et al., 2020).

5. BIOECONOMY SERVICES

The previous section analyzed three products from forest biodiversity and showed their importance for subsistence and income of Amazonian population. This cannot disregard the technological deficiencies that characterizes the exploitation and use of these products, as well as the incomplete and imperfect character of the markets in which they are commercialized, but it is important to notice that forest biodiversity also offers a range of services to human populations that are fundamental to the emergence of a new bioeconomy of standing forests and flowing rivers. These services are not always expressed in markets that value the social relevance of these products. The first one, exposed in item 5.1, is forest regeneration, an urgency derived from the fact that most of the areas destroyed in the Amazon in the last fifty years are abandoned or occupied with low productivity activities, particularly livestock. The second is tourism, and the third is the payment that different markets and public and private organizations may give to conserve and expand standing forests and flowing rivers.

5.1. Synergies between Bioeconomy and Forest Restoration

"Forest Landscape Restoration" encompasses a variety of strategies to increase tree cover in landscapes, from tree planting or silviculture to ecological restoration (Mansourian et al. 2017, Chapter 28). The restoration of forest landscapes not only re-establishes forest ecological functions, but also expands the supply of timber and non-timber forest products, as well as favouring ecosystem services and helping to recover biodiversity (Chapter 28). These changing landscapes then promote the emergence of new opportunities for increasing and diversifying supply chains, supporting innovation, creating jobs and income sources, and ultimately improving local people's well-being. In this section, we discuss the synergies that might arise from the current trend of increasing scale in forest restoration and the emerging new bioeconomy, bringing some examples of key on-the-ground experiences, as well as pointing out some directions to the future.

Seedling planting and agroforestry are among the most common strategies to restore forests in the Brazilian Amazon (*Aliança para Restauração da Amazônia* 2020; also see Chapter 28). Although agroforestry is found across all Amazonian countries, they are not widely distributed Amazonian landscapes, but rather are restricted to home gardens, while planned agroforestry systems are limited to local experimentation or pilot projects mainly funded by international cooperation, as discussed by Porro et al. (2012). Natural regeneration is another form of restoration that can be largely adopted given the wide distribution of abandoned agricultural lands in the Amazon (Smith et al. 2020, Silva-Junior et al. 2020). This strategy is cost-effective, considering cost minimization and high biodiversity and carbon returns (Ferreira et al. 2018; Lennox et al. 2018; Strassburg et al. 2020). However, it has still received little interest from the point of view of harnessing socio-biodiversity products.

Independent of the restoration strategy involved, business opportunities are often created across the restoration supply chain, involving, for example, seed collection, seedling production, nurseries, plantation management contracting and harvesting of forest products (Brancalion et al. 2017). In terms of seedling planting, perhaps the most prominent example is the *Xingu Seed Network* (*Rede de Sementes do Xingu*) in Brazil. This initiative led by the NGO ISA deals with seed exchange and commercialization, that during the last 14 years has traded around 250 tons of seeds from more than 220 species native to the Cerrado and Amazon, producing a revenue around BRL 4.4 million (~782,000 US dollars). The most prominent feature of the initiative are the main participants involved: more than 500 people including Indigenous groups, family farmers in agrarian reform settlements and city residents who are responsible for collecting seeds and other related activities in a cooperative. The strong involvement of local communities along the restoration supply chain (Schmidt et al. 2019) might inspire other initiatives and potentially increase the scale of restoration across the region. In the Xingu Network, the innovation lies in the articulation among these important actors, such as landowners, Indigenous people and governmental and non-governmental organizations.

Agroforestry is often seen as the most promising restoration strategy for targeting millions of family farmers living in the Amazon due to its potential in reconciling conservation and socioeconomic objectives (Porro et al. 2012). This approach has the advantage of decades of experimentation by governmental institutions, NGOs and farmers that culturally reproduce these traditional systems in the region across generations. The adoption of agroforestry and access to markets for the correspondent bioproducts associated with forest restoration can benefit from many decades of successful experience in production, cooperativism, trading and certification from different parts of the Amazon. Among emblematic examples led by family farmers in the Brazilian Amazon are the CAMTA cooperative in Pará (Box 30.1) and the RECA program in Rondônia, both focused on fruit pulp production, and ‘Café Apuí’ on coffee production in Amazonas.

It is true that in the context of ecosystem restoration, improvements are necessary in many agroforestry systems to achieve more fully the environmental objectives, such as increasing local biodiversity and structural attributes in a way that make them more similar to reference natural ecosystems.

Figure 30.6. Agroforestry system with banana, cupuaçu, taperebá, açaí, inga, mogno, andiroba and paricá. Photo: Embrapa/Ronaldo Rosa.

5.1.1. Fruit Trees

Independent of the necessary adjustments in the arrangements of agroforestry for restoration, there is already a large amount of traditional and scientific knowledge accumulated for the cultivation of the different native Amazonian species in agroforestry. This is the case for the most used species in agroforestry, such as açaí (*Euterpe oleraceae*), Brazil-nut (*Bertholletia excelsa*), cocoa (*Theobroma cacao*), cupuassu (*Theobroma grandiflorum*) and pupunha (*Bactris gasipae*). Currently, the economic revenue from these species comes from selling the fruits in natura, producing fruit pulps individually or in cooperatives.

The implementation of extractive activities of timber and non-timber forest products in agroforestry plots *(i.e.* in areas that are distant from large patches of primary forests) circumvents many of the limitations associated with extractive activities, which were widely discussed in this chapter (Section 4). Restoring areas with planted agroforestry allows farmers to have better control, such as increasing the presence and density of plant species of the highest economic interest and planting at a desirable distance from their households, thus facilitating the harvesting and processing activities. Managed agroecosystems can also enable or improve working conditions, as is the case for harvesting açaí fruits, whose palms grows taller in natural *várzea* ecosystems.

Açaí — one of the most desirable species for forest restoration by local farmers at present — is especially suitable for the restoration of riparian zones that are usually subject to flooding and has the advantage of easy propagation and high seed availability. The demand for the species may increase not only because of the growing economy of pulp production, but for industrial products with higher added value in medicine and the production of panels, as discussed in previous sections of this chapter.

Although agroforestry often includes a variety of plant species, the motivation for adopting the systems is often based on some individual species, such as the example of açaí mentioned above. The use of some key species can guarantee the viability of implementing restoration systems and the payback of the initial costs.

Another key native species for agroforestry in the Amazon region is cocoa due to its market prices and high demand in the national and international market. In the Brazilian Amazon, cocoa agroforestry plantations were mostly restricted to areas with rich soils in the Transamazon region of Pará, but recently efforts are being made to increase production in other regions of Pará. Different initiatives have been successfully promoted to produce chocolate locally. One example is that of a family farmer on Combu island in front of the capital Belém. The family produces up to 300 kg each month, and is led by Mrs. Nena, who fosters tourism, the main economic activity on the island. The family supplies high-end restaurants owned by celebrated chefs from Belém and São Paulo. Chocolate production also gathered 40 family farmers producing cocoa in agroforestry that organized themselves in the COOPATRANS cooperative (Cooperativa Agroindustrial da Transamazônica) to build an agro-industrial plant initiated in 2010 and creating the brand Cacaway shop that sells their products across the main cities of the state.

Cocoa agroforestry for restoring degraded pastures has also been the focus of a socioenvironmental project led by the NGO The Nature Conservancy (TNC) in one of the most pressing agricultural frontiers of the Brazilian Amazon. The *Cacau Floresta* project in the Southern Amazon region aims at encouraging small farmers and ranchers to recover deforested or unproductive areas by planting cocoa and other forest species of high economic value. TNC has announced the establishment of partnerships with Olam, from Singapure, and Mondelez from the US, two big international chocolate producing companies.

5.1.2. Timber

So far, the production of timber has received less attention than Non-Timber Forest Products (NTFP) in agroforestry or any other mixed-species restoration system. The adoption of silvopastoral systems, although having great potential to improve the vast areas of degraded pasture in the region, mainly count on exotic species, such as *Eucaliptus* spp. or Teca (*Tectona grandis*). This is likely due to a combination of factors, that include the limited market access for planted timber, the scarcity of knowledge on silviculture of native species and the lack of financial support for tree crops that involve more financial risk than short crop cultures. However, as addressed earlier in this chapter, the market for planted timber is increasing fast, following the decline in timber from native species and consumer preference for more sustainable products (Veríssimo and Pereira 2015). Certainly, the cultivation of timber species in restoration areas can boost the timber market that is among the relevant economic sectors in the region, along with mining and agriculture. Fostering innovation is crucial in this sector, which is still dominated by largely unspecialised activities. According to Veríssimo and Pereira (2015), in the Brazilian Amazon, wood production is made by 86% of sawmills, 8% processed timber, 5% laminate industries and 1% of wood boards. Agro-industrial activities for producing medium-density fiberboard (MDF) are promising as this sector requires large volumes of wood material. Currently, the timber species *Shizolobium amazonicum* (Paricá) that naturally occurs in Brazil, Peru and Colombia, is at present the single native species with the capacity to replace the widely used *Eucaliptus* and *Pinus* exotic species. *S. amazonicum* is extremely fast growing and has been planted in monocultures and in agroforestry systems in the region and has yield as high as or higher than *Eucaliptus* grown in 4–7-year cycles (Melo et al. 2014). Besides Paricá, plantations of Mahogamy (*Swietenia macrophylla*) also present high growth rates and commercial value (Veríssimo and Pereira 2015). Efforts for selecting a diversity of fast-growing native species need to be made, as well as to improve the efficiency of timber processing and the machinery used in the industry. In the Paragominas region (Pará state, Brazil), once infamous for being the largest source of illegal timber in the Amazon, currently represents a good example of industrialization in more specialized markets for planted timber. With eight companies distributed across six municipalities, it has been producing MDF board through processing Paricá timber (ABIMCI, 2016). The industrial demand for these products in the region were not met by the production across the ~38,000 hectares planted in recent years (Santos et al. 2018), indicating there is plenty of room for growth and to scale up landscape restoration.

5.1.3. Other Products

Beyond timber products, it is important to emphasize that restoration systems can provide diversified NTPFs, including rubber, gum, wax, fibres for dyeing, aromatics, medicines, that can source different industry sectors, from chemical to pharmaceutical, automotive and food (MAPA, *Plano Nacional de Desenvolvimento de Florestas Plantadas*). Currently, there are examples of oil species already traded in the market, which we present in earlier sections of this chapter, such as andiroba (*Carapa guianensis*), buriti (*Mauritia flexuosa*), a copaíba (*Copaifera* spp.) and babassu (*Attalea* spp.).

In conclusion, we have presented several promising examples of partnerships among local communities, private companies and NGOs for supplying Amazonian NTFPs to industries, such as Natura Cosmetics and the company Beraca that trade in oils and other bioproducts. Beyond the source of bioproducts, private companies gain huge additional benefits from improving their socioenvironmental image while associating it to the Amazon. The relationship between private companies and local communities might bring positive local benefits, but are full of complexities and caveats (Morsello 2006). It is important in these partnerships to guarantee the empowerment and autonomy of IPLCs involved (Ribeiro 2009).

Innovation in funding, support and partnerships linked to restoration activities are emerging in the region. For example, the Belterra and Conexsus Sustainable Connection Institute that is specialized in mobilizing a large network of associations, cooperatives, small and medium companies to increase access to funding and markets for sustainable bioproducts in the region. These innovative systems should complement strong public policies, such as credit for restoration and institutional programs for purchasing products from family farmers engaged in restoration. The Food Procurement Program (PAA) and the National School Meals Program (PNAE) in Brazil serve as good examples of initiatives that purchase socioenvironmentally friendly produce from smallholders (Resque et al. 2019).

Beyond the marketing of products, restoration using agroforestry is important for the well-being of rural families, providing food security through the cultivation of a wide variety of high-value products and a range of other benefits such as climate mitigation and improved water and soil quality (se Chapter 28).

5.2 Tourism

Tourism is one of the fastest growing activities in the world. The growing interest in areas of great natural beauty, cultural diversity and historical components, are among the most relevant factors for increasing tourism demand (Cho, 2010). The Amazon has all these components due to the enormous wealth of its socio-biodiversity. Calderón (2015) highlights the biological, cultural and geographical diversity of Ecuador as a great strength and opportunity for the development of tourism in that country, an argument that can be easily extended to other countries in the Andean Amazon. Sinclair and Jayawardena (2003) point to a similar conclusion for Guyana. Castro et al. (2015) emphasize the importance of environmental quality for visitation in protected areas for tourism in Brazil. Similarly, a work from Escolhas Institute (2019) shows that, according to Amazonas Cluster Turismo, touristic areas are much less affected by fires and devastation than where tourism does not occur.

It is important to emphasize that nature is considered as a factor for deciding the traveler's destination not only for foreign travelers, but also for domestic tourism. A study of the Comisión de Promocion del Peru para la Exportación y el Tourism (PromPeru, 2019) found that, for 53% of domestic tourists, "landscapes and nature" are a decisive factor in the choice of destination.

However, the development of this potential in the Amazon is still limited in all countries of the region. Rodrigues et al. (2018) estimated in 2016 a total of 16.8 million visitors in 209 National and State Parks in Brazil, with the economic impact of these visitors estimated at between US$ 1 and 2 billion annually, and creation of thousands of jobs. However, only a small portion of this visitation, less than 5%, occurred in the Brazilian Amazon. A similar result is presented by a study on ecotourism in Colombia, which shows that the Colombian Amazon is a relatively marginal destination compared to the flow of visitors across the country (Sánchez and Tsao, 2015). The study from PromPeru (2019) also does not consider places in the Peruvian Amazon on the list of the most visited destinations in Peru.

It is therefore important to understand the challenges for tourism in the region. Ochoa-Zuluaga (2019) argues that tourism in the Amazon is characterized by the fact that in the same space and territory there are two distinct worlds, the commercial capitalist and the native communities, which, although partly integrated into the market, maintain traditional forms of subsistence and social relations that are in conflict with conventional tourism practices. Capucci (2016), when analyzing the growth potential for tourism in Suriname's countryside, highlights the problems that the contact with foreigners can originate in case this expansion is not properly controlled, both for nature and for communities that were previously traditionally isolated. Taking the Colombian Amazon as a reference, Ochoa-Zuluaga (2019) contrasts the strong expansion of visitation in the region around Leticia, with an increase in hotels and services for tourists, while the social conditions of the settlements of the region remain quite precarious, despite the considerable increase of business, visitors and income. The challenge is to conduct this tourism expansion in a way that brings benefits to Amazonian populations well-being, without significantly changing the spatial configuration of countryside towns and settlements, especially IPLCs that are more isolated from external contact.

For this reason, it is paramount to develop a differentiated approach in which the growth potential of tourism in the Amazon is made compatible, and not antagonistic, to the bases of socio-biodiversity, which, ultimately, is its main promoter. This means that it is not enough to just conserve the region's natural characteristics: it is necessary to respect and value its historical and cultural legacy.

In an assessment of the potential of community-based tourism in Indigenous areas in the Colombian Amazon, Quintana Arias (2017) argues that, by understanding art and territory as a social construction of the tourist reality, the importance of the symbolisms and myths that outline the social praxis resulting from the intersection between cultural and biological diversity increase. This appreciation of ancestral knowledge is also manifested in other cultural, artistic and religious manifestations that make the Amazon so special. This includes both popular festivals of religious origin, such as the *Círio de Nazaré*, in Belém do

Pará, as well as secular events, such as the *Boi de Parintins* Festival, in the Brazilian Amazon. It is also necessary to explore the cultural mosaic of the diverse peoples who were displaced to the Amazon, as can be seen in the extraordinary ethnic diversity of Guyana, where the multiplicity of native languages finds a mirror in African, Asian and European immigration, resulting in one of the most culturally diverse population of the planet, amid an equally diverse natural environment.

To this end, it is important to avoid myths as the "returning to El Dorado" or other fantastical constructions that identifies the forest dwellers as "good savages". As argued by Sinclair and Jayawardena (2003, p. 402), “The product in Indigenous tourism in Guyana and Surinam is often an equation that is as much myth as reality”.

Following principles from the World Tourism Organization and reviewing experiences in the Ecuadorian Amazon, Arroyo and De Marchi (2017) identified criteria to be respected in the development of tourism, especially community-based: (i) self-determination, for the implementation and execution of the activity; (ii) plurality, reflecting all the players involved in touristic work; (iii) participation, which allows visualizing horizontal relationships in the practice of tourism activity; (iv) scope, in which articulation with other economic spheres is reflected;(v) transparency, which constitutes the honest and ethical management of the resources available for the touristic activity; and (vi) progressivity and planning for the activity.

Another important aspect is to foment the demand for tourists who are interested in a differentiated type of tourism. Sinclair and Jayawardena (2010) highlight the potential to develop routes integrating the Amazon with the Andes, with possible connections with Inca trails, road maps exploring the connections through the Guyanese Massif, and, taking advantage of the river routes throughout the entire region. Benevides et al. (2018), in a study for Roraima (Brazil) underline the importance of social innovations and creativity to increase the hospitality and well-being of visitors. This type of stimulus is important to encourage demand, considering the insecurity, transport difficulty, lack of infrastructure among other problems for the travelers.

Arroyo and De Marchi (2017) draw attention to the principle that sustainable tourism is a means for development, but not an end in itself, and that tourism is like an "iceberg", consisting of a small visible part (experienced by tourists) and a large non-visible component, composed of a mosaic of local initiatives, strategies and investment coordinated by the public. Therefore, it is essential that this invisible part also benefits the communities through better living conditions, and generates positive citizenship effects for the local communities. This requires coordination efforts between market operators, development institutions and local populations, respecting their heterogeneity and recognizing that, in community-based tourism, communities are the managers, producers and administrators of their own touristic product and are in control of the business. Tourism activity significantly affects the strengthening of the community organization, its bonds and identities, and generates significant processes of appropriation, management and organization of the natural and cultural heritage. In this sense, it is also worth mentioning the tourism connected to Saint Daime Ayahuasca, with important impacts for cities as Pauini, in the State of Amazonas (Brazil) (AMVCM, 2021).

The recognition of this immense heterogeneity requires an in-depth knowledge of resources, accessibility networks and use of touristic resources so that an articulated tourism policy can be developed for the Amazon, while respecting the bases of knowledge, culture, religion and local traditions that guarantee the conservation of socio-biodiversity.

5.3. Payment for Environmental Services

The Amazon is home to numerous terrestrial and aquatic ecosystems that provide invaluable environmental services (see Parts I and II of this Report). The most evident and debated ones are those offered by the native vegetation, especially by its dense forests. Its more than 7 million km², for example, are home to around 10% (30,000 species) of plant species known to science (Steege et al., 2013). There are more than 16,000 species of trees distributed among four hundred billion specimens. The wealth is so great that, in a single tree, it is possible to find more species of ants than in the whole United Kingdom (Wilson, 1987).

In addition to being a repository of immense biological diversity, the Amazon stores a massive carbon stock. A volume equivalent to approximately a decade of global emission – about 10 billion tons of carbon per year, taking 2019 emissions as a reference (Friedlingstein et al. 2019). If this volume was released into the atmosphere via deforestation, it would greatly aggravate global climate change. The environmental service of keeping such wealth and playing an important ecological role for human well-being, however, has been little recognized, valorized and compensated. In this sense, PES can potentially contribute to the protection of Amazonian ecosystems and their environmental services in large scale.

Compensations for ecosystem services are economic incentives for the conservation or sustainable use of natural resources, aiming to induce behavioral changes regarding an ecosystem or natural environment through the valuation of one (or more) of its services (e.g., climate regulation, water conservation) (Wunder, 2015; Pagiola et al., 2016).

There are countless PES trials and experiments in the Amazon. These involve the protection of water resources (Moreno-Sanchez et al., 2012; Montoya-Zumaeta et al., 2019; Young et al., 2019) and of biological diversity (Machado et al., 2020). Castro et al. (2018) estimate that PES initiatives aimed at forest conservation in communities in the States of Acre (Certificate of Family Production Unities) and Amazonas (Forest Grant) would benefit over 44,000 individuals in the period between 2009-2015, allocating over R$ 40 million in this period. Other correlated initiatives involve compensations for GHG reduction due to deforestation decrease, the Reduced Emissions from Deforestation and forest Degradation, plus the sustainable management of forests, and the conservation and enhancement of forest carbon stocks (REDD+) of the United Nations Framework

Convention on Climate Change (UNFCCC). In general, through REDD+, entities (jurisdictional or not) that make an effort and are able to demonstrably reduce GHG emissions from deforestation, are eligible to receive compensation. REDD+ also contemplates (because of the "+") actions aimed at the conservation, management and expansion of forests. Although this mechanism is being debated for over a decade by UNFCCC and several independent groups, there are still bottlenecks to be overcome to achieve an effective advance of the final objectives of REDD+ (Angelsen et al. 2012; Duchelle et al. 2018, West et al. 2020). In the tropics, several pilot REDD+ initiatives have been implemented, including in the Brazilian and Peruvian Amazon (Sunderlin et al. 2014, West et al. 2020). Although this set of REDD+ initiatives demonstrate promising results (Simonet et al. 2019; Sunderlin et al. 2014), as well as a consolidation and profusion of REDD+ initiatives (Sunderlin et al. 2014), they still face several bottlenecks for its consolidation. These include problems related to (i) leakage (reduction of emission in a certain area leads to an increase in emissions in another area), (ii) benefits distribution (Gomes et al. 2010, Moutinho et al. 2014, Streck 2020) and (iii) double counting (when different entities claim the reduced emissions for themselves), among others. Beyond projects, REDD+ advanced to jurisdictional modalities, that is, involving subnational governmental entities. This approach aims to promote a stronger control of the aforementioned bottlenecks (Nepstad et al. 2012). The Amazon, especially the Brazilian, historically prospered from jurisdictional REDD+ involving the states of the region. The Brazilian State of Acre was a pioneer in this process, structuring government governance mechanisms (Duchelle et al. 2014, Guerra and Moutinho 2020) propelled by the REDD+ Program for Early Movers (KFW, 2021) of the German government. The same jurisdictional REDD+ construction process has been occurring in the nine States of the Brazilian Amazon, especially the States of Mato Grosso, Roraima e Maranhão (Guerra e Moutinho 2020). Besides Brazil, the impetus for the proposition of jurisdictional REDD+ among Amazonian countries, mainly Colombia e o Peru, can be summarized through the effort maintained by the GCF Task Force (GCF, 2021), a climate and forest task force that involves governors of states and provinces not only from the Amazon, but from several states (38 in total) throughout the world that hold tropical forests.

In sum, despite numerous bureaucratic obstacles (Brazil and other Amazonian countries still lack consolidated regulations for their REDD+ national strategies), both technical and political (West et al. 2020, Wunder et al. 2020), and of reactions from social movements (Grupo Carta de Belém, 2009) that are contrary to REDD+ mechanism, the fact is that jurisdictional REDD+ programs are rapidly advancing. A proof of that is that independent initiatives to qualify, monitor, and inform subnational REDD+ activities are also multiplying. Among the most recent ones, there is the ART (2021) - Architecture for REDD+ Transactions, an initiative that aims to bring security for potential private investors in REDD+ actions.

Despite the advances in PES initiatives, there are also numerous bottlenecks to be overcome so that this type of bioeconomy approach effectively gains the necessary plenitude and security. On the demand side, it is necessary to guarantee that forest conservation projects generate carbon credits that are eligible to participate in the European Union Emissions Trading System (ETS) and others where the charging for emissions surplus is mandatory. On the supply side, both PES or its REDD+ variant, it is still necessary, for example, to advance in the means for achieving socio-environmental safeguards (Pascual et al., 2014; Gardner et al., 2012), in the construction of procedures for the equal distribution of benefits (Moutinho et al., 2017) and in the guarantees for the positive effects of these payments or compensations to be the most comprehensive, effective and lasting (Ezzine-de-Blas et al., 2016) as possible.

Still, the consolidation of PES or REDD+ as economic alternatives for the conservation and sustainable use of natural resources will depend on their progress in Amazonian countries as public policies. The most recent legislative initiative regarding PES was the enactment of Law 14.119 (1/13/2021) by the Brazilian Congress, that created the National Policy for Payments for Environmental Services (PNPSA; Brazil, 2021), considered an advance towards environmental protection. In summary, PNPSA paves the way for third sector institutions, companies and individuals to promote environmental conservation actions and be compensated for this. The Brazilian government vetoed numerous articles of this new Law, which compromised its effectiveness, transparency and governance (Coalizão Brasil, 2021). Fortunately, these vetoes were overturned by the Brazilian Congress, enabling a quicker progress in the implementation of the Policy. In addition to that, there are numerous PES initiatives being implemented by the Amazonian states of Brazil and other countries, especially jurisdictional REDD+ (e.g., Simonet et al., 2019; Stickler et al., 2018; Palmer et al., 2017).

In the current scenario of large-scale deforestation in the Amazon (Murad and Pearse 2018, Brito et al. 2019, Azevedo-Ramos and Moutinho 2020), PES and REDD+ mechanisms represent important allies in mitigating drastic changes in climatic patterns and in promoting sustainable development, and should not be disregarded.

6. TRANSITION, AN EMERGING PROCESS

The strengthening of bioeconomy – following the ethical principles highlighted in this chapter – is one of the most important conditions for the achievement of the Sustainable Development Goals worldwide. However, the contribution of tropical forests and particularly the Amazon in offering products and services that contribute not only to the welfare of people living in this territory, but to the entire humankind, is still negligible. So far, this chapter has explained the main reasons for this chasm that separates the Amazon from the scientific and technological frontier of the bioeconomy. This session aims to summarize the challenges and opportunities encountered in the transition from the current forest socio-biodiversity economy to a new bioeconomy of standing forests and flowing rivers.

Social transitions (such as from the economy of destruction to the economy of knowledge of nature) are emerging processes that depend on long-term factors, on unexpected shocks, but also on individuals and organizations that play the role of political, institutional or moral entrepreneurs. These individuals and organizations play a decisive role in the emergence of transformative social networks (Burt, 2000), especially in times of turbulence. This is particularly true today, with deforestation, violence and the invasion of protected areas in the Amazon, which, paradoxically, can make room for the emergence of innovative solutions (Folke, 2020). The protagonists of these innovations establish bridges, alter agendas and bring narratives aimed at the transformation that they aspire (Fligstein, 2001a). The transition to an economy of knowledge of nature is neither exclusively nor fundamentally technological, although science and technology have a crucial role. It involves, for example, infrastructure, new markets, changing social preferences and, in the case of bioeconomy, the crucial relationship between science and traditional knowledge. It also involves cultural changes in the social vision regarding forest socio-biodiversity and in the educational processes themselves. As shown by Herrfahddt-Pähle et al. (2020), these cultural changes tend to value and expand proposals and alternatives that until then remained confined to specialized niches and that start to appear not only as necessary, but as viable.

The transition is already underway. It was paradoxically accelerated by the increase in deforestation, fires, invasions of Indigenous territories and public areas, and the impacts of COVID-19 on the forest dwellers. Much more than a localized episode, forest destruction and the violence associated to it have undermined the social legitimacy foundations of the resource use models utilized so far.

The landscape was profoundly transformed due to a shock. At this moment, actors who develop models that, until now, were in the niche stage, gain prominence: new knowledge gains audience and legitimacy, and starts to dispute a decisive political-cultural space (Fligstein, 2001b) in the organization of the markets. A window of opportunity for unconventional innovations opens.

It is essential that this window of opportunity is not limited to the products analyzed above and to the immense diversity of products that the Amazon produces, but that it opens equally in two directions. The first, as will be seen below, involves science and technology. The second refers to the commodities sector. It is true, as was seen in the previous chapters, that agricultural, livestock and mining activities that currently account for most of the production value and exports in the region are systematically supported by socioenvironmentally destructive practices. Concurrently, there is a growing international and internal pressure on each country in the Amazon demanding that destruction stops and a true regenerative economy emerges in its place. It is in this sense that the aforementioned “Accord for the Amazon” includes the commodities sector as a bioeconomy component.

Imagining a healthy bioeconomy alongside predominantly destructive practices is a truly dystopian scenario. International and Latin American markets are increasingly demanding that the supply of soy, meat, cotton and corn coming from the Amazon is supported by regenerative techniques that contribute to the strengthening of forest resilience and regional biodiversity. Current knowledge already makes the association between farming, livestock and forest more than experimental in many situations, with the support of scientific research in each country. These productive alternatives open the way to the drastic and necessary reduction of the damages that the agricultural supply coming from the Amazon has predominantly caused until now. The experience of Paragominas, in the Brazilian State of Pará and the Green Municipalities Program (da Costa and Fleury 2015), aimed at reducing deforestation and improving the productive performance of livestock, is providing contributions for a profitable and more environmentally sustainable agriculture. The agricultural and livestock commodities sector has every interest in ensuring that all its production is certified not only as free from deforestation, but also as a vector for enrichment and sustainable use of the forests within their properties. Productive practices that reduce and tend to eliminate polluting inputs will be increasingly important and subject to be implemented, due to family farmers’ crop diversity tradition that tends to accompany even conventional cassava or dairy production.

In short, the emergence of a new economy of standing forest and flowing rivers is a transition that can be compared to the global challenge studied by Geels et al. (2017) when examining the urgent "deep decarbonization". It requires the transformation of consolidated productive systems (albeit of low productivity and responsible for destructive practices), whose inertia is broken both by the loss of social legitimacy of these prevailing practices, and by the emergence of innovative activities that, with changes of national, regional and international contexts, gain new opportunities to assert themselves. It is clear that, just as in the face of the urgent "deep decarbonization", the mobilization of diverse actors, as well as the application of public policies aimed at accelerating the transition, are fundamental. It will be seen below.

It is clear that, similarly to the urgent "deep decarbonization", the mobilization of diverse actors, as well as the application of public policies aimed at accelerating the transition, are paramount.

6.1 The diversity of actors

The acceleration of deforestation, forest fires and illegal and criminal activities in the Amazon, especially from the beginning of 2019 (fundamentally, but not only, in Brazil; Butler, 2019) resulted in an intense mobilization, not only of activist organizations, but, in an unprecedented way, of business sectors (from the Amazon and other global countries) that until very recently did not actively participate in public discussions about the destiny of the Amazon and the opportunities represented by a new and dynamic bioeconomy. The return of the United States to the Paris Agreement, the adoption of the New Green Deal with ambitious commitments to decarbonize the North American economy, the adoption of the Green Deal in the European Union and important commitments expressed by major GHG emitting countries such as China, India and Japan have altered the international framework, making the immediate halt of the Amazon's destruction a global priority.

The social landscape within the Amazon itself has also changed significantly. Many of the most prominent activist organizations in the Amazon are focused on strengthening entrepreneurship for the sustainable use of the forest. This is expressed not only in the search for business partners and the valuation of niche products within protected areas, but in an effort to find solutions that allow to expand the offer and improve the market conditions of innumerable socio-biodiversity products. Folke et al. (2020) show how large transnational companies are in the process of incorporating sustainability into their practices. NGOs that work with entrepreneurship (often in alliance with national research organizations, such as EMBRAPA) are decisive actors for niche solutions to be incorporated into the practices of economic actors.

In addition to the search for economically viable solutions by various non-governmental organizations and the change in the guidelines of important segments of large corporations (financial and non-financial), it is also important to mention the mobilization of two fundamental segments: the scientific community and different governmental sectors. In the Amazon of the beginning of the third decade of the 21st century, what Folke et al. (2020, p. 44) formulated as a premise for a collaboration between human societies and the biosphere is taking place: “Broad coalitions among citizens, businesses, nonprofits, and government agencies have the power to transform how we view and act on biosphere stewardship and build Earth resilience”.

The most emblematic examples of the formation of this diversified network of forces that are not only opposed to the advance of destruction, but that are jointly looking for pathways that enable the emergence of a strong and competitive bioeconomy in the region, come mainly from Brazil, but they are present in the Amazon as a whole. It is important to mention some recent facts in this respect.

The first was an open letter in June 2020 to the Brazilian government, published by global investment funds which collectively manage over to USD 4 trillion in assets, in in which they warn that the destruction of biodiversity represents a threat to their assets. Attacks to Indigenous peoples are also cited in the document (Pinto Cagliari, 2020).

On July 14, 2020, seventeen former finance ministers and former presidents of the Brazilian Central Bank released a letter entitled “For a low carbon economy”, in which they emphasized the risks derived from climate change and called for zero deforestation in the Amazon and the Cerrado, criticizing the invasion of conservation units and Indigenous territories (Chiaretti, 2020a). A week later, in an unprecedented pre-competitive agreement, the three largest private banks in Brazil (Bradesco, Itaú and Santander) launched an integrated plan for the sustainable development of the Amazon, in which bioeconomy plays a strategic role, and the urgency of stopping invasions of public areas and Indigenous territories is also mentioned (Abramovay, 2020b). The initiative's originality lies not only in the pre-competitive agreement among the three banks, but also in the fact that the initiative is overseen by an advisory board composed of some of the most important scientists and socio-environmental activists in Brazil.

In the same period, the food processing companies Marfrig and JBS released diagnosis showing that, although they have control over the origin of the cattle they slaughter, this knowledge does not extend to the entire production chain, thus favoring destructive practices (Notícias Agrícolas 2020). At the same time, they announce goals to eliminate deforestation from their entire value chain.

There is no guarantee that the announcement made by these large global corporations will, in fact, contribute to zero deforestation and the emergence of a knowledge economy of nature in the Amazon. It is clear that the success of these initiatives largely depends on public policy measures in dimensions that fall outside the scope of action of these sectors, especially with regard to land policies and the repression of illegality and crime. The role of sub-national governments and local legislative bodies in this regard is extremely important. At the same time, it is important that the investments made by these companies aimed at strengthening biodiversity go through competitive processes and undergo rigorous critical evaluations by specialists.

Since 2014 and as a preparation for the Paris Conference, it was established the Brazilian Coalition on Climate, Forests and Agriculture, which prepared proposals that decisively influenced Brazilian positions at COP 2015. Comprised of companies, activist organizations and personalities linked to socioenvironmental issues, the Coalition was important for the emergence in 2020 of the previously mentioned Concertação pela Amazônia (Valor Econômico, 2020b). A consultation to its website allows us to see that the Concertação (which has no defined legal character and is described as an informal and diversified network) has the ambition to address topics ranging from public security and violence, to the investment profile needed for the sustainable development of the Amazon. For each of these hemes, Concertação is organizing public discussions and requesting documents from specialized consultants that enrich these discussions and seek to expose the multiple points of view of the diverse players participating in this network.

This diversity of players was also essential for the establishment of a pact among state governments in the Brazilian Amazon, that stimulated not only attempts to counter the destructive practices prevalent in the region, but is also leading to the creation of development plans towards a new bioeconomy of standing forest and flowing rivers. Several authors of these plans actively participate in the Concertação initiative. Concertação also proposes to gather, process and pave the way for the analysis of economic, political, cultural and socio-environmental information on the Amazon through the Amazônia Legal em Dados (“Legal Amazon in Data”) platform (Arapyau, 2021). The Platform responds to a request from the Consortium of Governors of the Legal Amazon.

This unity formed by scientists, representatives of IPLCs, socio-environmental activists, financial and non-financial companies and state government representatives, is very recent and largely emerges as a reaction to the disruption of socio-environmental policies led by the Brazilian government in relation to the Amazon. Many of the companies that have become protagonists of these initiatives have, until very recently, acquiesced and engaged in economic practices that have led to deforestation and disrespect for the rights of IPLCs.

The important thing when thinking about the transition to the standing forest and flowing rivers bioeconomy, is that the circle of forces that assumes public commitments (backed by promising governance) around constructive practices is broad and seems to be growing. Among the Amazonian countries, Brazil is the one in which this convergence of heterogeneous players is gaining greater relevance. This is one of the most promising signs of the Amazon's transition towards sustainable development.

7. NAVIGATING THE NEW BIOECONOMY: CHALLENGES AND RECOMMENDATIONS

The utilization types of the gigantic Amazon territory, the organizations that operate in it, and the institutions that govern the region's economy, are so varied that they require specific approaches when it comes to proposing pathways for the transition to a new bioeconomy of standing forests and flowing rivers.The strengthening of niche markets responds to very different intervention dynamics and logics than the ones that aim to popularize the use of forest socio-biodiversity products that can integrate value chains connected, for example, to animal feed or to the supply of agricultural commodities. Strengthening Amazonian cities as gastronomy centers based on the valorization forest socio-biodiversity products is a different challenge from that represented by the discovery and use of relevant molecules for the pharmaceutical industry: encouraging cooking schools that are dedicated to present textures, flavors and odors of forest products requires organization and investments that are very different from those related to relevant discoveries for the pharmaceutical and cosmetic industries.

Despite this diversity and based on the ethical-normative recognition of the value of standing forests and the respect for the material and spiritual culture of the people who inhabit it, it is possible to list general objectives that will favor a strong and dynamic bioeconomy in the Amazon.

The previous chapters of this Report showed that the most important of these objectives is the immediate interruption of destructive practices that contribute to generating an institutional environment incompatible with the intelligent, fair and promising use of forest socio-biodiversity. Nothing in the Amazon today is more important than restoring the security of protected areas, Indigenous territories and public lands that continue to be invaded. Similarly, using the intelligence and integration of homeland security forces of each country is urgent, since criminal activities, as shown by the work of the Igarapé Institute, have become international (Abdenur, 2019). In this sense, it is essential to press the monetary authorities of each country to trace the origin of illegal gold, widely exploited in the Amazon as shown in a recent study by Instituto Escolhas (2020).

With regard to the ambition for the establishment of a strong, competitive and fair forest socio-biodiversity economy, a few fundamental objectives can be cited (without exhausting the options):

7.1. Cities, infrastructure and internal markets

A new bioeconomy of standing forests and flowing rivers cannot emerge as an enclave of scientific and technological advancement in a region so marked by poverty, inequality, violence and the lack of access to basic citizenship conditions, as quality education, basic sanitation, access to health and participation in dynamic labor and product markets.

As discussed in previous chapters, it is in the cities that the overwhelming majority of poverty and misery is concentrated in the Amazon. In the Brazilian case, it is in the cities of the Amazon that the worst living conditions indicators are found, as shown by the Social Progress Index (IPS, 2021). The current forest socio-biodiversity economy depends on the cities, where its products are marketed and where most of the income it generates is spent. In addition, even families that live mainly on forest products seek urban households where basic health and education services are concentrated. Even the organization of farmers or populations that make their living from harvesting takes place mainly in cities. The gastronomic use of forest socio-biodiversity products in Amazon cities itself has the potential to become a factor in generating employment and income in cities (Atala, 2012).

This means that improving urban infrastructure, both in large centers and in typically rural municipalities, is fundamental to the emergence of a dynamic bioeconomy. What the geographer Bertha Becker called the "Consolidated Settlement Arc", referring to human occupations at the edge of the forest, has a decisive influence on the very development of the socio-biodiversity economy.

However, an important warning needs to be made here. The only information on Pan Amazonian urbanization rate dates back to 2009 (UNEP et al. 2009), when it was estimated that 60% of the region's population was urban. The difficulty in updating this information is due not only to the precariousness of demographic censuses in different countries in the region, but also from the criteria that define the urban population. In Brazil, this definition is based much more on rules defined by municipal administrations than on social realities. These rules guide the Brazilian Institute of Geography and Statistics (IBGE) classification, which consider that 72% of the population of the Amazon would be urban. Veiga (2003) proposed a typology of three categories, used by Favareto et al. (2014) for the Amazon context. According this typology, one third of the Brazilian Amazon population lives in unmistakably urban municipalities, 26% are in "intermediate" municipalities and no less than 40% are in typically rural locations, even when they live in the center of these municipalities. These 40% live in municipalities with less than 50,000 inhabitants and a demographic density of less than 80 inhabitants per km^2. Frequently, in the centers of these small municipalities, live people with strong ties to agricultural and even forestry activities, and who seek a second urban residence due to health or education facilities. We will not go into the technical details of this tripartition, but it is clear it is important for the necessary infrastructures and the relationship with bioeconomy, as it suggests a greater influence of the socio-biodiversity economy than would be expected in a highly urbanized region.

The current infrastructure emphasis in Pan Amazon (Bebbington et al, 2020), is to guarantee the flow of mineral and agricultural commodities, and they frequently end up becoming vectors of deforestation and encouraging the invasion of protected areas. Facilitating the mobility of rural populations so that they have access to urban services, improving information systems to ensure accurate river transportation schedules, implementing high-quality internet, stimulating technical and university courses in small municipalities, are relatively low-cost investments that can stimulate the emergence of promising markets for socio-biodiversity products, as well as markets that depend less on intermediaries that block the economic dynamism that the bioeconomy can have. It is also essential that cities contribute to strengthen the markets in which family farmers operate, through cooperatives focused on the industrialization of what they already produce. Improving the industrial use of cassava, for example, is something that simultaneously strengthens the economy of the inhabitants of the interior of the Amazon and generates multiplier effects in the cities. But for this, two fundamental conditions are needed: reducing information asymmetry and strengthening state support for rural economic activities.

7.2 Reduce information asymmetry

Information on markets is one of the most important premises for forest products to be commercialized based on modern, competitive structures that allow the improvement of income and the expansion of opportunities for their producers. For this, price guarantee policies are important, but insufficient. It is essential that the productive chains of socio-biodiversity products are mapped, allowing transparency to all participants in its operations. More than that: this mapping has to offer information, in a wide and accessible way, to the producers of the traded goods. The experience described by Gabre-Madhin (2012) on the grain stock exchange in Ethiopia is an excellent inspiration for the emergence of an open and efficient system of socio-biodiversity products price information. It is clear that there are particularities in these products that differentiate them from grains, which are the subject of the Ethiopia commodity exchange. The important thing, however, is that the producers themselves (either farmers or extractivists) have an active participation in the information system that would no longer be in the hands of conventional intermediaries. Trade would thus lose its personal assistance nature and gain market transaction status.

Today, as seen in previous sessions, price information is concentrated on the purchasers of the goods. In the Brazilian Amazon, an initiative of the NGO Imazon, which for more than a decade has been collecting and disseminating the prices of non-timber forest products in the states of Pará and Amapá, stands out (Guimarães et al. 2019). In general, purchasers control the price of what they sell to the forest dwellers through *aviamento* and, many times, of the debts linked to it. Information from institutionalized sources, such as a commodity stock exchange, is a fundamental component for the emergence of dynamic and competitive markets, according to a proposal elaborated by Freitas and Schor (2020).

7.3 Seals of quality, scale and entrepreneurship

The Origens Brazil Seal operates in conservation units and Indigenous territories, and has achieved important results in incorporating products from these territories into value chains of medium and large companies in the rubber sector, in the use of Brazil nuts, and in the processing of peppers, herbal oils and other forest products. But it is clear that, despite their importance, the income generated by these products is necessarily limited by the very care required by a fundamentally extractive economy, which is supported by the activities of populations living in non-densely populated areas and based on techniques that seek not to alter the environments in which they are located. The presence of companies such as Natura and of Non-Governmental Organizations (NGOs) such as Instituto Socioambiental, IMAFLORA, ICV and others paves the way for important improvements not only in production techniques, but also in the transparency of economic processes for the communities that are the real protagonists of these activities. The introduction of accounting to these communities, and the effort to link them to diversified markets, expands their capacities and their autonomy.

Nevertheless, it is clear that these products - sold on a relatively small scale and in niche markets - are a tiny fraction of the productive potential of the forest. This is one of the reasons that motivated the development of initiatives that seek to scale the utilization of forest socio-biodiversity products and services. Most of these initiatives are not limited to the forest itself, but also seek to encourage sustainable practices by family farmers, settlers and farmers. The aforementioned Conexsus, for example, does an important work of organizing, legalizing and introducing accounting techniques to associations and cooperatives. Its activity aims to reduce the immense transaction costs embedded in the relationship between companies and communities that supply socio-biodiversity products. As previously mentioned, these transaction costs lead companies to seek for traditional intermediaries, which prevents associations and cooperatives themselves from further benefiting from the dynamic and competitive markets. Conexsus leads the movement "Business for the Earth", which aims to add "market intelligence to community enterprises."

Belterra is an organization that is developing land use models that combine forests, agriculture and sometimes livestock (see Box 30.1). Within and outside the Amazon, these models have been successfully implemented, displaying the possibility that productive scale is compatible with the strengthening of biodiversity and a varied set of ecosystem services.

There are now technical means (coming from the use of low-cost digital devices) so that the tracing of production processes can be presented to markets as a competitive asset of the Amazonian products. The Brazil nut incorporated into Wickbold bread that reaches tens of thousands of urban consumers in Brazil is equipped with a QR code that reveals the origin of the product, who produced it, and the socio-environmental situation of the territory from where it comes. But these devices also have the potential to show the markets the productive processes linked to the regeneration of degraded environments or the associative forms linked to their offer. Natura has extensive experience in taking advantage of these assets.

And even products that currently contribute so much to forest destruction, such as beef or soy, can be transformed: first, the fundamental tracing premise (as planned by Marfrig and JBS) is that products are exposed transparently and accessibly to its consumers and to all components of their value chains. This tracking can become an important competitive asset for Brazilian livestock, showing, for example, that in the Amazon and as a product of work along its value chain, livestock relies on pastures' management that offset methane emissions from the enteric fermentation of animals. The work of PECSA (spin-off of ICV, an important NGO operating in the state of Mato Grosso, Brazil) is a successful example in this direction. And in a context where large importers of protein grains focused on animal feed seek to replace these products with local alternatives, the link between grain production in the Amazon and the strengthening of the biodiversity of the environments in which these grains are grown will be increasingly important (PECSA, 2020).

Productive scale has always been connected to the simplification and homogeneity of natural environments transformed to expand the offer of agricultural products. One of the most important challenges of a new bioeconomy of standing forests and flowing rivers is precisely that of integrating gains of scale organically with the strengthening of socio-biodiversity. In this sense, a Royal Swedish Academy document advocates for "strengthening resilience through investing in portfolios of ecosystem services for human well-being in diversity-rich social-ecological systems" (p. 43).

These organizations operate mainly on the basis of philanthropic contributions from international and national organizations, and all of them explicitly express their ambition to encourage the participation of private capital in business organization and in the promotion of entrepreneurship itself. In this sense, one of the most important conclusions of this chapter is that activist organizations (in all their diversity) play and will play a decisive role in increasing private participation in entrepreneurship aimed at a new bioeconomy of the standing forest and flowing rivers. These are the organizations that have the capacity to influence the world, the language, the objectives and the methods of private investors to the realities of the Amazon, so different from those with which they are used. In the first version of the document published by the three Brazilian banks, for example, it was explicitly said that investments would be aimed at promoting promising monocultural activities. The dialogue between the banks and the activists was important to stimulate the necessary learning process so that the notion of scale is not transposed to a tropical forest in the same way as it is applied to a planted culture enterprise.

Natura is being able to make production on a considerable industrial scale compatible with the strengthening of forest socio-biodiversity, as shown in Box 30.2.

7.4 Governmental support for strengthening markets

A commodity stock exchange will be further strengthened if governments adopt policies to guarantee minimum prices for forest socio-biodiversity products. Such policy will help to take these products out of informality by generating production and market data and statistics and, therefore, stimulating public policies supported by quality information. Furthermore, these policies encourage the calculation of production costs and, therefore, of the competitive opportunities of these products. These programs already exist in Brazil, but the budget for this type of program is still very low, and the information does not reach the producers who need it the most due to the lack of technical assistance and to the low level of productive organization.

The Brazilian Government guarantees the policy of minimum prices for 17 extractivist products, of which nine exist in the Amazon region: açaí, andiroba, babassu, extractivist rubber, buriti, extractivist cocoa, Brazil nuts, murumuru, mangaba, baru, carnaúba, juçara, macaúba, pequi, piassava, pinhão and umbu. In addition to minimum prices, other policies can play an important role in strengthening forest socio-biodiversity. In Brazil, the National School Feeding Policy made an important contribution to the strengthening of family farming by establishing a minimum level of the children's meals that should come from this segment. In the Brazilian Amazon, this has been an important opposing factor to the tendency for school lunches to composed of ultra-processed products and of much lower nutritional value than local diets. In addition to schools, other institutions can support the stabilization and strengthening of the demand for socio-biodiversity products, such as military barracks, public hospitals and prisons. Institutional markets are a way to offer security to producers and, thus, consolidate trading routes that contribute to better organize their activities.

7.5. Science, Technology and Innovation

Improving living conditions in Amazonian cities and strengthening markets for socio-biodiversity products is fundamental, but insufficient. For humanity to enjoy the potentials of the most biodiverse forest in the world, it is essential to reduce the gap that separates the Amazon today from the global scientific and technological innovation frontier. This ambition presupposes, of course, the expansion of investments in science and technology in the region, coming specially from the public authorities of each country, state and region. The budgets of the most important research organizations in the Amazon are far from enough from the territorial, demographic and natural importance of the region, and of the potential that it could represent for the development of the countries in which it is located and for humanity as a whole. Two of the most important research centers in the Brazilian Amazon (the National Institute for Amazonian Research and the Emílio Goeldi Museum) have been suffering a systematic reduction in their budgets and, frequently, the resources that should be directed to them are contingent (Silveira, 2019). As a result, botanical, ethnobotanical and parabotanical research (carried out by “*mateiros*”) ends up not being developed. It is paramount to strengthen Amazonian organizations, courses at different levels (from the training of young people in the field to postgraduate studies) and give them a strategic focus on socio-biodiversity knowledge and sustainable use. In addition, the emergence of a strong bioeconomy presupposes the creation of new research centers that are committed to achieving relevant results vis-à-vis the use of these resources. There are indications that the conventional mechanisms for evaluating scientific research (e.g., publications in high impact journals) are insufficient to direct researchers' efforts towards the strategic objective of strengthening the emergence of a new bioeconomy. It will also be necessary to promote incentives for innovation production, including processes, techniques, brands and patents.

In addition to government resources, international cooperation also plays a decisive role, not only by helping to finance research, but also through the exchange of talents focused on biodiversity knowledge and, above all, on its utilization potential. This confluence among academic knowledge, traditional knowledge and the experience in bioeconomy innovation coming from all over the world, can be significant in attracting venture capital investments in innovative initiatives.

It is paramount that investments in science and technology in the Amazon also strengthen an educational system that focuses on understanding and using its socio-biodiversity. This involves, on the one hand, clear protocols coming from the private sector that ensure that their initiatives will result in the strengthening (and not in the destruction) of the natural and social tissues responsible for maintaining the forest socio-biodiversity. Moreover, the schooling of students and researchers must focus on understanding and sustainably using this biodiversity. Today, teaching is much more focused on a small number of crops, mainly exotic, planted both for agriculture and logging. The recent creation, in the state of Amazonas (Brazil), of the Forest Social Business School, associated with the State University of Amazonas and the Institute of Advanced Studies of the University of São Paulo, is an important step in reconciling new education modalities, and new approaches on biodiversity together with the strengthening of entrepreneurship (UEA, 2020). This type of exchange between institutes and universities in the Amazon and in Brazilian regions, which, due to the historical process, have more research structure, is a very promising strategy.

In this sense, it is very important to highlight the existence of Botanical Gardens, Herbariums, Archeology Museums, Living Museums as the Kuahi of the Oiapoque Indigenous peoples, among others. Investments in science, technology and innovation in the Amazon are supported by an already existent scientific community that is located not only in the state capitals (Brazil, 2020b), even if they need to be greatly expanded and strengthened. Some efforts for technological studies were carried out in the Brazilian Amazon, with the creation of the Amazon Biotechnology Center, in Manaus, in addition to BIOTEC Amazônia and the Instituto Tecnológico Vale, in Belém. In addition, organizations focused on the professional capacitation of workers (in the Brazilian case, the National Service of Support to Industry can be cited) have resources, structures and laboratories that can be employed at the service of improving the performance of industrial transformation of biodiversity products. Sanitary challenges that hinder nut exportation, for example, could be overcome by initiatives from this type of organization.

In 2013, the Science, Technology and Innovation Plan for the Amazon recommended the integration of initiatives from multiple governmental and non-governmental bodies focused on the knowledge of socio-biodiversity and on the technological applications that could be best adjusted to its sustainable use (CCGE, 2013). Initiatives such as the Leticia Pact, signed by Brazil, Colombia, Peru, Bolivia, Ecuador, Guyana and Suriname, with the goal of protecting the Amazon, right after the explosive increase of the fires of August 2019 (Heads of State and Heads of Delegation of the Plurinational State, 2019), show that, today, this integration can and must go far beyond national borders, stimulating the exchange of information and experiences between researchers, technicians and entrepreneurs from the eight countries and the national territory that constitute the Amazon. This is an essential dimension of the bio diplomacy previously mentioned in this chapter, as well as in a letter published in Science magazine in which researchers from several countries ask the signatories of the Leticia Pact to strengthen transnational cooperation initiatives for the protection and development of the Amazon (Prist el al., 2019). The importance of biodiplomacy is expressed even in international forums that do not mention it explicitly, but that advocate for the strengthening of socio-biodiversity as the most important pathway for the sustainable development of the Amazon. The Synod of Bishops, held at the Vatican in October 2019 (Vatican, 2019) is a good example in this regard.

7.6 Biodiversity molecules and shared benefits

Although the Amazon is considered by many as a medical treasure where the "largest drug dispensary in the world" is located (Skirycz et al., 2016), the use of these materials by the pharmaceutical industry falls far short of its potential. Over the past forty years, several techniques emerged (i.e., robotics, bioinformatics, high throughput screening, combinatorial chemistry, molecular biotechnology, CRISPr), reducing the pharmaceutical industry's interest in natural components (McChesney et al., 2007). However, as demonstrated by Skiryks et al. (2016), this substitution strategy in the search for molecules was not successful, promoting the sector's interest in the development of natural products. New drugs derived from natural products corresponded to 60% of all drugs approved by the Food and Drug Administration agency (FDA) between 1981 and 2010. Research also shows that natural products have biochemical properties that make them superior to what is obtained by the information libraries held by major pharmaceutical companies. The title of the article by Harvey et al. (2015) is emblematic: the "re-emergence of natural products for drug discovery in the age of genomics".

The value and the benefits of tropical forests biodiversity for the pharmaceutical industry presume, above all, the existence of cutting-edge technologies aimed at their identification and understanding of their potential use. The sophistication of these technologies and, above all, the complexity of the information to which they will be applied, can only be successfully tackled through strategic alliances involving public and private research organizations. Skirycz et al. (2016) propose that the chemical libraries of large pharmaceutical companies are shared through pre-competitive agreements. No laboratory alone can overcome the challenge of knowing the entire biodiversity of the rainforest and their uses. Of the 15,000 higher plants estimated to have medicinal properties, less than 200 are used in the pharmaceutical industry. Reducing this gap is a scientific task that can give rise to decisive technological innovations for laboratories, companies and the societies that are protagonists of it.

AstraZeneca's chemical library became available to a network of more than 130 research centers (Skirycz et al., 2016). The Joint European Compound Libraries also intends to share five hundred thousand compounds that belong to seven major companies (Besnard et al., 2015).

Similarly to what have been done by the European countries, it is essential that the eight countries and the national territory in whose territories is located the greatest biodiversity on the planet also organize the strengthening of scientific research, the exchange of information, as well as regional and international cooperation around this contribution that biodiversity can offer to the world through the advancement of scientific research. For this, it is crucial that the devices already established internationally in the Convention of Biological Diversity (CBD) are improved, for sharing the benefits obtained by research with the populations living in the forest and with the scientific institutions involved in the discoveries (Joly and Santos 2019). Today, these mechanisms do not encourage research and the industrial use of their results and hardly benefit the populations of tropical forests and the advancement of scientific knowledge.

7.7 State and local information systems

One of the most important premises for the emergence of a new bioeconomy of standing forests and flowing rivers is that public and private actors are able to count on quality information, not only on production and prices, but also on the social conditions of the territories in which they operate. The capacity of national statistical bodies is low when it comes to products and peoples from regions to which access is often difficult. At the same time, it is difficult to develop and comply with development plans in the absence of this state and local information. This is a field in which international cooperation, cooperation between Amazonian territories, and the skills accumulated in the most developed areas of Amazonian countries will play a fundamental role.

8. CONCLUSIONS

With the greatest socio-biodiversity on the planet, where knowledge accumulated for at least ten thousand years resulted in a unique material and spiritual culture, the Amazon rainforest, over which eight national states exercise their sovereignty, is a common good of humanity. The forest (as an ethical value) and the contribution of the people who inhabit it and contribute to its conservation, is the starting point of any project aimed at the emergence of a new bioeconomy in the Amazon.

It is urgent to overcome the paradox of the distance between scientific and technological innovations that characterize the growing importance of the bioeconomy for contemporary societies, and the scarce contribution of tropical forests to these achievements.

This chapter sought to address this paradox from three perspectives. Firstly, the strengthening of the natural and social networks of the tropical forest is not justified only for instrumental reasons. Despite the immense utility of its products and services, it is essential that the conservation and regeneration of the Amazon rainforest are not merely a means, but an end. However, the ethical value of protecting the forest and the people who live in it also has a decisive instrumental counterpart: given Latin America's deindustrialization in recent decades, the sustainable use of socio-biodiversity, supported by science and technology, is a one of the most promising ways for the region to reduce the distance that today separates it from the scientific and technological frontier of contemporary innovation.

The second perspective that guides this chapter's approach focuses on the knowledge of the socio-environmental reality on which the relationship between society and nature in the Amazon is based. A new bioeconomy of standing forest and flowing rivers will only emerge if it is part of a broad process of improving the living conditions of those who live in the Amazon. Without this, it would confine itself to an enclave, in a non-propitious environment to offering the goods and services that can be expected of it.

Hence the third perspective, that of ambition. Making tropical forests a vector for the development of life sciences’ applications for the whole of humanity is a decisive aspiration. But this presupposes that bioeconomy opens the way not only to value the knowledge of those who directly explore the forest, but also to favor the social emancipation of those who are currently in a situation of vulnerability.

This dual objective (scientific guidance on the use of forest socio-biodiversity, and forest products and services as a means of combating poverty) needs to be addressed in an organically articulated manner. Nobody has the recipe for this articulation, but it will surely result from the joint action of forest dwellers, activists who defend them, organizations that foster entrepreneurship, from the participation of urban populations in the transformation of forest products, and from social coalitions that may give rise to these transformations. Social change processes as ambitious as that of the emergence of a new bioeconomy of standing forests and flowing rivers depend on the widespread change in the views of political and economic actors on the predominant forms of their activities.

This presupposes public policies that immediately interrupt the current prevalence of violence, illegality and destruction in the region. In addition, these policies will have to integrate the protection of the forest and the use of its products and services, to the strengthening of infrastructures aimed at improving the living conditions of Amazon inhabitants, and not only (as has been prevalent until now) to the circulation of farming and mineral commodities in the region.

It is important here to insist on an innovative methodological option. The great distance between the forest socio-biodiversity economy and what it is currently identified as bioeconomy globally, does not allow that the usual categories are used when tropical forests and, in particular, the Amazon are at stake. Establishing bioeconomy as the domain par excellence of the life sciences (emphasis on the definitions mentioned in the introductory section of this chapter) means eliminating the overwhelming majority of tropical forest activities, products and services from its analysis scope. At the same time, it is clear that the replacement of the current economy of destruction for an economy of knowledge of nature (which, of course, involves science and technology) is a fundamental ambition for a new economy of standing forest and flowing rivers. In other words, although the current forest socio-biodiversity still lacks an important vector in its use in science, this is a limitation that sustainable development in the Amazon will have to overcome.

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10. CORE GLOSSARY

Agroforestry Systems: Dynamic, ecologically based, natural resource management system that, through the integration of trees on farms and in the agricultural landscape, diversifies and sustains production for increased social, economic and environmental benefits for land users at all levels.

Anthropized region of converted forest: Usually associated with areas opened by productive activities.

Aviamento: System in which workers' debts to those who provide them with basic subsistence goods end up in forms of personalized dependency that can lead to slavery.

Biodiplomacy: Global and integrated approach to the management of global challenges that affect the biosphere.

Conserved region: Where conserved forests are predominant.

Double counting: When different entities claim the reduced emissions for themselves in REDD+ projects.

Indigenous and Local Knowledge: Indigenous and local knowledge systems are understood to be dynamic bodies of integrated, holistic, social and ecological knowledge, practices and beliefs pertaining to the relationship of living beings, including people, with one another and with their environment. Indigenous and local knowledge is grounded in territory, is highly diverse and is continuously evolving through the interaction of experiences, innovations and different types of knowledge (written, oral, visual, tacit, practical and scientific). Such knowledge can provide information, methods, theory and practice for sustainable ecosystem management. Indigenous and local knowledge systems have been, and continue to be, empirically tested, applied, contested and validated through different means in different contexts.

Jurisdictional REDD+: REDD + initiative hosting a national or subnational governmental administrative unit.

Leakage: Reduction of emission in a certain area leads to an increase in emissions in another area.

Neglected and Underutilized Species: Neglected and underutilized species are those to which little attention is paid or which are entirely ignored by agricultural researchers, plant breeders and policymakers. They are wild or semi-domesticated varieties and non-timber forest species that are not typically traded as commodities.

Regatão: Traveling trading system that transports goods from cities to the countryside, also buying products from forest populations.

BOXES

Box 30.1 - Agroforestry Systems (AFS)

The need to reconcile productive land use with forest conservation and regeneration has stimulated the emergence of AFS. EMBRAPA conducts relevant research and advisory in this area, but the practice has come a long way (EMBRAPA, 2020). In Tomé-Açu, in the State of Pará (Brazil), agroforestry practices began in the end of the 1960s, when agrobiodiversity served as a solution to a serious crisis caused by diseases and low prices in black pepper monocultures (Homma, 2016). The diversified consortium of plant species for multiple uses in the decaying areas of black pepper consisted of an adaptation of ancient traditional forms of cultivation in unique production systems in the region, self-named Tomé-Açu Agroforestry System (SAFTA) by promoters of these systems. The region has become not only an important export hub for products with higher added value (especially for Japan and the United States), but also a reference for agroforestry innovation in Brazil and abroad.

In 1987, farmers implemented an agroindustry to process the pulp of the fruit produced on SAFTAs, but since the 1930s they had already founded a cooperative that would later become the Mixed Agricultural Cooperative of Tomé-Açu (CAMTA) (Homma, 2016). Today, the cooperative counts with more than 170 members and 1,800 family farmers registered to supply raw materials. Commercialized products include black pepper, cocoa beans, herbal oils and regional fruit pulps. Cooperative members estimate on their website that around 10,000 direct and indirect jobs are generated from the initiative. Although many exotic commercial species are grown in SAFTAs, especially black pepper, Amazonian native plants are integrated in these systems, such as cocoa (*Theobroma cacao*), cupuaçu (*Theobroma grandiflorum*), açaí (*Euterpe oleracea*), taperebá (*Spondias mombin*) and Brazil nuts (*Bertholletia excelsa*). Native wood species are also cultivated with some frequency, such as ipês, cedar and paricá (Barros et al., 2009).

Tomé-Açu farmers have been cultivating, over time, integrated production systems, with greater diversity of products, guaranteed access to markets, and greater added value resulting from agro-industrial processing, being considered a major success of the Amazon region. What can explain these niches of more sustainable agricultural systems in regions (such as the Northeast of Pará) where forms of production that degrade ecosystems and promote little socioeconomic development predominate? Answers to this question are certainly important to boost the bioeconomy sector and design large-scale transformations in the Amazon.

Tomé-Açu was founded out of Japanese immigration to the Amazon in 1929, as part of a cooperation treaty between Brazil and Japan (Homma, 2016). While this strong local uniqueness restricts many generalizations, some lessons emerge from this case and may possibly be applied to other realities. Cooperativism and associative work have always permeated the production systems of that region, regardless of the cultures produced (Saes et al., 2014; Tafner-Junior and da Silva, 2011). Immigrants took a very innovative stance in the face of crises and experimented, based on technical support, both in production system and in the products.

Above all, the technical and financial support of the Japanese government, in various periods of crisis, played an important role in the success of agricultural enterprises. This financial support was important not only to promote agricultural investments directly, but also to build essential infrastructure, overcoming the deficiencies of the State, as was the case of rural electrification in the region (Tafner-Junior and da Silva, 2011). This example shows, among other aspects, how important it is to promote cooperation and symmetry among players (Futemma et al., 2020), in contrast to the exploitation and clientelism relations that currently dominate the markets in the Amazon, a topic widely discussed in this chapter.

Finally, it is worth noting that many family farmers in the region (settlers) also reproduce AFS inspired by the Japanese descent community (Futemma et al., 2020). It is important to encourage biodiverse agroforestry and expand markets for new products so that these niches can progress towards a more sustainable regional development.

Box 30.2 - O caso da empresa Natura Cosméticos

Operating since 1999 in the Amazon region, Natura Cosméticos, a company of the Natura & Co group, today the 4th largest beauty company in the world, has built a business model based on the use of socio-biodiversity products and services, pioneering the combination of production at scale with promotion of sustainable development in the region.

Throughout the years, it established relationship with agro-extractivist communities, generating income and encouraging local training, field research (such as forest management, agro-extractive systems and sustainable agricultural production) and technological innovation to the generation of inputs.

The challenge of combining technological feasibility at scale, quality, meeting demands, and a vision of sustainable development with social and environmental impact, led the company to stipulate a series of processes and, with the Natura Program Amazonia, to locally establish itself with “Ecoparque”, an Industrial park in Benevides, Pará, in 2011.

It invested in research and development of ingredients and forest production/management, local production and training of small producers, support for the institutional strengthening of communities and cooperatives, infrastructure training of the chain, and the establishment of a policy of sustainable use of products and services of socio-biodiversity based on CBD principles and on the provisional measure established in Brazil in 2001 regarding the use of biodiversity. Some of the raw materials used by Natura are also pre-processed in the communities themselves, through community agro-industries, which increases the added value for the communities, or are processed at Ecoparque.

This industrial park was built by the company for the local production of inputs and products, and also with the objective of attracting others interested in the construction of a symbiotic industrial pole for sócio biodiversity. It also counts with the presence of the Innovation Center in the Amazon, and of the Management of Partnerships and Socio-biodiversity Supply. So far, the German company Symrise is established in the Ecoparque, and other supplier partners were settling in the region, as the Beraca.

To make logistics and management feasible, the company has been working to promote local development, through a strategy called sustainable territories, regions where there is a high commercial relationship with socio-biodiversity chains, and where intersectoral collectives are supported, with communities, government, institutions, NGOs, investors such as GIZ, USAID and Fundação Banco do Brasil, among others, as well as with companies and universities, for an expanded vision for the development of standing forest economy hubs.

In total, the company had developed 38 bio-ingredients by 2019, including about 5,100 families, 33 agroextractive communities, 14 socio-biodiversity hubs (mainly in the states of Pará, Amazonas and Rondônia), and 11 community-based agroindustries.

Over the past 8 years, Natura reached a biodiversity business volume in the region of around R$ 1.8 billion, which includes the purchase of inputs, the sharing of benefits and direct investments, the influence of conservation on an area of 1.8 MM hectares and more than 3,000 people capacitated in professional courses. In 2007, it supported the formation of the Union for Ethical Biotrade (UEBT) for the application of CBD practices and principles in input chains in different sectors of the economy.

Recently, UEBT practices were converted into a monitoring system (2014) and in a certification process (2018), both applied by Natura and other companies. UEBT certification ensures ethical biocommerce for the payment of fair prices, biodiversity conservation and social development of the Amazonian chains or any other chain of certified biodiversity (Natura, 2018; Natura, 2019).