AMAZON BIENNIAL 4.0

ART GIVING VISIBILITY TO SUSTAINABILITY AND TECHNOLOGY ISSUES IN THE AMAZON

Project "Amazon 4.0": Defining a Third Way for the Amazon

The relevant question

Is it possible to reconcile the Amazon's economic development and the rainforest's conservation? Over the past two or three decades, the national debate has been divided between two opposing views, with insufficient attempts at conciliation. On the one hand, the path of completely isolating large tracts of jungle for conservation purposes (hereinafter referred to as "first way"). On the other, the defense of a model of "Supposedly sustainable" development that includes agriculture/livestock and mining (hereinafter referred to as "duplicate").

Reality shows that none of these pathways, or even the hypothesis of convergence between them, is bringing satisfactory results because the constant expansion of the frontier for *commodity* production, especially beef, and industrial-scale mining, drives deforestation. Another problem is the plans to build infrastructure for energy production in the Amazon region (hydroelectric dams).

To think of a new paradigm of sustainable development: the **Third Amazon Way**.

The forests of the Amazon region are the consequence of millions of years of evolution during which nature has developed a great variety of biological assets (food, single molecules, genes of life, metabolic pathways, etc.) in aquatic and terrestrial ecosystems. This process has resulted in enormous biodiversity and extraordinary richness of natural products. These biological assets and biomimetics (relative to

the functions and processes present in nature) are being increasingly valued by the **Fourth Industrial Revolution** (or **Industry 4.0**) for the elaboration of pharmaceutical, cosmetic, and food products, or even in the research of new materials, energy and mobility solutions, with significant profit potential.

However, so far, all this latent wealth is far from being properly harnessed and channeled back to the region, both to conserve this unique biome and to improve the living conditions of the indigenous, the caboclos, the riverside dwellers, the former unassisted settlers and even the cities rooted in the Amazon.

In our view, the Amazon Third Way represents an emerging opportunity to develop a "green economy" that harnesses the full value of a "permanent productive forest" to, with the help of new physical, digital, and biological technologies already available or evolving, established a new model of socially inclusive economic development.

Yes, it is possible to create the conditions for the flourishing of a vibrant and inclusive economy that respects the forest and its rivers, the fauna, flora, and traditional Amazonian peoples, but the challenges are neither few nor small, among them the fact that the Amazon is still largely disconnected from the most advanced centers of technological innovation 4.0 and bioeconomy on the planet. What lessons can we draw from the first and second ways?

A model that allows access to the full range of riches of the forest itself as the basis of a strong, locally based economy, without deforesting, polluting, and compromising biodiversity? To arrive at this model, let's examine the first and second ways and what lessons we can draw from these two paths already tried, to a greater or lesser extent.

The first route corresponded, especially in the last decades of the 20th century, to the delimitation by the Brazilian State of vast protected areas, such as indigenous lands and conservation units such as parks and national forests, as a way of ensuring that a significant and sufficiently large area of the Amazon

biome was preserved in perpetuity.

Currently, just under 50% of the forest is under this condition. However, although protected by law, even these protected areas are not immune to forest loss. Satellite data show evidence that fires rage in reserves near already deforested areas, especially after years of intense drought. For example, after the historic drought of 2010, almost 30% of the Xingu Indigenous Reserve was affected by forest fires, of an anthropic nature.

In summary, climatic extremes and proximity to a process of intensive agricultural occupation represent a concrete threat to protected areas. Other factors, such as invasion for illegal logging, mining, and land grabbing, make this "passive" protection not translate into a guarantee of conservation of the forest, rivers, flora, fauna and traditional cultures that live in it.

The second way proposes a regional development model that enables activities such as grain production in a monoculture system and extensive cattle ranching in areas already partly deforested between the Cerrado and the beginning of the Amazon, as well as mining or even logging, in a controlled manner. With plenty of available land, excellent insolation and water conditions, high-level research, and an increasingly vibrant agricultural sector, Brazil has surpassed other countries in food production and has become a global leader. But how long will agribusiness continue to make growing gains, undoubtedly necessary for the country's economy, without expanding its borders towards the heart of the jungle, putting the future of the Amazon at serious risk?

Third way: a bioeconomy with deep roots in the Amazon

So what can be done? The climate crisis and the global threat to biodiversity require innovative solutions such as the concept of an Amazonian Third Way, which proposes a new paradigm of sustainable development for the region. A model that uses all the knowledge provided by science, technology and innovation, and strategic planning for the flourishing of a bioeconomy based on the idea of a "standing forest with flowing rivers, valuing biodiversity and the sustainable work of communities places."

This innovative economy must have deep roots in the Amazon and not see the region only as a place of extraction/production of primary inputs to be used by bioindustries from distant places. It should also generate local and diversified bio-industries, value-added products at all links of the value chain, jobs and social inclusion.

We list below some examples of products based on biological assets from the Amazon with high added value (potential or realized). There are fragrances for perfumes such as rosewood oil, priced at $ 200 a liter, used as a component of classic perfumes such as Chanel No. 5. The Brazil nut almond oil, used in cosmetics and sold at 30 dollars a liter, when marketed in capsules as a food supplement, is worth 150 dollars a liter.

The ucuúba, which was mainly used to make broom handle, gained new value after research identified that butter made from this plant has huge potential in the cosmetics industry. Today, the annual income generated by a standing ucuúba tree is three times higher than that generated by cutting down the same tree, which reinforces the argument of the viability of harnessing biodiversity in an intelligent and sustainable way.

But the most eloquent case of success among agroforestry products is the açaí, which can be managed both on a small and large scale. Until 1995, it was consumed basically in the North region, but in the last 20 years it has conquered the rest of the country and global markets. Present in almost all municipalities in the region, the net profit from açaí production ranges from 200 dollars per hectare per year in unmanaged systems to up to 1,500 dollars per hectare per year in managed agroforestry systems (values for the state of Pará).

The production of açaí pulp already exceeds 250,000 tons per year, benefits more than 300,000 producers and adds at least 1 billion dollars to the Amazon economy each year.

Camu-camu has 1,888 mg/100 g of vitamin C, while orange contains only 53 mg/100 g and tangerine with 112 mg/100 g. Buriti has twice as much vitamin A as carrots.

Amazon plants contain biochemical secrets, such as new molecules, enzymes, antibiotics, and natural fungicides that can be synthesized in the laboratory and result in high-value products. Leafcutter ants use some leaves as a blanket for growing fungi and deliberately avoid other leaves rich in natural fungicides. A study of the plant species that leafcutter avoids can help identify new, efficient natural fungicides. Also, the study of the genome of the species can facilitate this process.

There are still molecules used in the bioenergy industry, such as the Amazonian enzyme Beta glucosidase, recently discovered in an Amazon lake, which, when used to manufacture ethanol from sugarcane, increases productivity by up to 50%.

In the Brazilian flora, more than 240 species of plants are used as the basis of cosmetic and pharmaceutical products and 36 as the basis of herbal medicines, but the potential is infinitely greater. In the Amazonian flora, more than 450 species are already known and traditionally used, but how many can be transformed into economic assets as valuable and profitable as açaí or cupuaçu chocolate? And how many new products can emerge from research conducted with hundreds of new species discovered annually in the region?

The Amazonian fauna also produces active ingredients for allopathic and herbal medicines such as the venom of the snake Surucucu, whose value reaches 4,000 dollars per gram, and Bothrops Aster, which reduces the blood pressure of the victim, making it less reactive and, transformed into medicines such as Captopril, helps hundreds of millions of people to control hypertension.

Finally, biodiversity is the origin of biomimetic knowledge, in which structures and processes of nature are studied and translated into concepts, principles, and processes to generate new technological solutions. Whatever the input used, biological or biomimetic, it is possible to develop locally based value chains by adding the new technologies of the Fourth Industrial Revolution.

The fact is that the Amazon contains an infinite number of opportunities to find functionalities to meet the most diverse human needs in the 21st century. It is up to us, Brazilians, to lead the research to appropriate all this knowledge.

Industry 4.0 and how it can add value to the forest

To operationalize the innovative transformations proposed by the Third Amazon Way, the concept "Amazon 4.0" emerges, which aims to add to the economic potential of the assets of the Amazonian socio-biodiversity the new technologies and possibilities that emerge from the Fourth Industrial Revolution or Industry 4.0.

Industry 4.0 is characterized by cyber-physical systems, the internet of things, communication networks, Artificial Intelligence, and convergence of computational, digital, and materials biological technologies.

Our proposal provides for the use of these new technologies to help transform natural resources into products of greater added value, ensuring that they are produced and consumed sustainably, reach the most developed markets and benefit from this access and, just as importantly, that this whole process is strongly linked to local communities, which should be their main actors and beneficiaries.

Among settlement projects, towns, cities, villages, indigenous peoples, villages, there are 4,438 communities so defined by the IBGE spread throughout the Legal Amazon. Despite its extension, the Amazon is dotted with communities where people live who can and should participate in this new "economy of forest biodiversity." However, there are many difficulties in implementing projects that add value to forest products, whether mineral, agricultural, or extractive in nature. Factors such as isolation, lack of infrastructure, logistical difficulty, complex processing, production volume, quality assurance, access to equipment and training, access to markets and experience in closing truly advantageous deals are some of the real challenges that are imposed and hinder the economic development of the Amazon.

How to equate this series of challenges with the help of new technologies? There are many possibilities. An example is the Opportunity rover, sent to Mars, where, remotely controlled, it takes pictures, does experiments, generates energy, and exchanges data with its terrestrial base. Despite the essential differences in terrain and climate, much of what has been learned from these unmanned, remotely operated space vehicles can be applied to the Amazon.

In the logistics aspect, the distances that must be traveled by river are enormous, and, for a product originating from a distant riverside community to reach an airport in the region, days of travel are necessary.

Unlike primary *commodities* that result, for example, from mining or extensive soybean planting, which weigh thousands of tons and have no other transportation alternative than railways, waterways or highways, other forest products, if properly processed, can have their weight and volume greatly decreased, while the added value increases, facilitating air transport using unmanned vehicles to a port or airport and, from there, to the world.

The enormous Amazonian distances also pose a challenge to the perishability of the products. There are fruits of great nutritional potential that, after being harvested, do not last long. But one can use freeze-drying techniques, generating high-value material for manufacturing ice cream, yogurts, etc. Examples are cupuaçu, açaí and camu- camu powder, which maintain almost all the nutritional qualities of the original food.

The use of solar energy in the Amazon communities, where the rate of solar radiation is much higher than in European countries that already invest heavily in this technology, is something totally feasible, at reasonable costs and without any damage to the forest, its rivers and inhabitants.

In Industry 4.0, everything is connected: machines, people, businesses. Connecting the entire Amazon is undoubtedly a huge challenge, but there is already a Brazilian geostationary telecommunications satellite coming into operation precisely to provide broadband in any region of the Brazilian Amazon. There are plans by the federal government to install fiber optics to thealong major Amazonian rivers via underwater cables. Not to mention other even more disruptive solutions, such as mega-entrepreneur Elon Musk's idea to put into orbit a constellation of satellites around the Earth to create a kind of global *Wi-Fi*.

Another issue is to train the inhabitants of distant communities to correctly use the equipment needed to add value to their products. In addition to distance courses, there are training techniques using virtual or augmented reality, which allows virtual interaction with machines with varying degrees of complexity and precision, as if they were physically within reach of the hands.

And how to provide technical assistance for a state-of-the-art equipment installed in the middle of the jungle? Equipment used in Industry 4.0 has sensors that make it possible to monitor them remotely and make reprogrammings, revisions and repairs. It is also possible to assess the need for spare parts, even before there is a failure, by sending the part to the place where the machine is weeks or months in advance.

To generate sustainable new business opportunities, access to qualified markets and a wider universe of consumers is essential. Digital platforms have revolutionized the way we consume, from the moment of research and product selection to the forms of payment, delivery, etc. We can use these tools to spread the products of the Amazon to all corners of the world.

Sustainable businesses of the present and the future require scaling, and in innovation ecosystems, many startups use technology to enable businesses that once seemed unsustainable. Small producers can, for example, come together virtually in

cooperatives and associations to join forces and break the cycle of isolation.

Local producer communities can also be valued with new technologies, creating bridges between producer and consumer situated in different parts of the planet through virtual or augmented reality. With a real-time 360-degree camera it is possible to record and follow people working thousands of km away and interact with them.

What can be done now: Creative Labs of the Amazon

Previously we defined concepts, fundamentals and challenges. However, there is an urgency to put into practice this great potential of the Amazon to generate a new and powerful bioeconomy from the development of local capacities. For this, we created a concept of Creative Laboratories of the Amazon, designed to develop capacity for an inclusive socioeconomic transformation based on the economic use of biodiversity.

Mounted on tents or floating platforms, these field laboratories could conduct research and propose solutions through the interactive fusion of traditional, scientific and technological knowledge. Members of local communities and students would be able to work in partnership with teachers, researchers, entrepreneurs linked to startups and specialists in fostering and supporting small businesses and sustainable businesses, such as SEBRAE, as well as professional training organizations, such as SENAI. This varied group of people gathered in an environment of training, creation and prototyping will drive the emergence of a bioindustry that makes the most of the potential of Amazonian biodiversity.

An example of what these laboratories could achieve was designed in a case study for the potential that fruits such as cocoa and cupuaçu, both from the same family, have for the production of chocolate and cupulate (type of chocolate made from cupuaçu seeds) of high quality and nutritional value. The study, which details the total verticalization of this value chain, includes aspects such as intelligent machines, automated equipment, energy and communication infrastructure in the forest, innovative transportation, etc.

We have also developed a Laboratory to explore all the possibilities of Brazil nuts, which can produce oil, flour, milk, paste and several other ready-to-eat products, with high added value, while in its raw state it is sold for about R$ 2/kg, a very low value.

In the Creative Genomics Laboratory, the community will be able to do genomic sequencing of species known to them for many years, but not yet studied scientifically in a deeper way. Portable sequencing and recording systems on *blockchain* systems, in order to secure intellectual property rights, will be available.

The seven foundations of the Amazon 4.0 concept

Seven fundamentals summarize the Amazon 4.0 concept:

1. **Accumulated knowledge represented by Amazonian biodiversity.**

Nature possesses intrinsic knowledge as a result of the evolutionary process, which generates constant competition for space and food. For a species to excel, it had to "invent" a better solution than competition for a given existential challenge and/or context. The consequence is continuous

Evolution and improvement of functionalities that today we We can understand them as "nature's own technologies".

2. Ability to understand the intrinsic knowledge of the forest.

Before the invention of microscopes, humanity was unaware of microorganisms, their actions and complex interactions. Currently, with extremely precise digital microscopes associated with other technologies of the Fourth Industrial Revolution, we have exponentially increased the ability to read, understand and predict a huge range of natural processes and thus can greatly expand our knowledge about the forest and its possibilities.

3. Application of this accumulated knowledge to improve human life.

Answers to the most diverse needs of humanity can arise from the in-depth study of natural processes, flora and fauna, both in the medical and food fields, cosmetics, pharmaceuticals and research of innovative materials. Industry 4.0 makes it possible to create and test new products with more dynamism, agility and effectiveness. An example is 3D printers, which make it easy to create prototypes of new products at low cost.

4. Production of goods and services from biodiversity.

Using abundant inputs in extractive and agroforestry systems and transforming them into something of value, through the bioprocessing industry, is the essence of what we propose for the Amazon. With the technological resources and facilities available today, this is entirely possible.

5. Building a bioeconomy that is both local and global.

The challenge lies in ensuring that products made from forest resources are valued and consumed around the world and, at the same time, are firmly rooted in local traditions, life and economy.

6. Equitable distribution of socioeconomic benefits.

Everyone stands to gain from the supply of products resulting from the sustainable exploitation of the forest. In addition to the legal system and the current institutional mechanisms for registering rights, there are innovative digital technologies that can greatly increase the reach and impact of this equitable sharing of benefits, generating more jobs and an inclusive and socially just economy.

7. Intrinsic valorization of the Amazon biome.

The most effective form of forest conservation in the medium and long term is precisely the engagement of societies at the national and international level in its defense, maintenance and sustainable exploitation.

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