AMAZON INSTITUTE OF TECHNOLOGY

AmIT 2022

AMIT Amazon Institute of Technology

arapyaú

MIT BRAZIL

ie]

AMZ4.0

AMAZON INSTITUTE OF TECHNOLOGY

AmIT 2022

(1) This pre-feasibility study for the creation of an Amazon Institute of Technology (AmIT) is part of the Terceira Via Amazônica-Amazônia 4.0 program. This initiative is under the auspices of the Institute of Advanced Studies, University of Sao Paulo (*http://www.iea.usp.br/pesquisa/grupos-pesquisa/amazonia-em-transformacao-historia-e-perspectivas/amazonia-4.0*), and the NGO Instituto Amazonia 4.0 (www.amazonia4.org). This program has been additionally developing the Amazon Creative Laboratories and the Amazon Rainforest Business School.

(2) This study was funded by the Arapyau Institute (www.arapyau.org.br), a private, non-profit institution, founded in 2008 with the aim of promoting dialogue and networking for the collective and perennial construction of solutions based on sustainability.

AMIT Amazon Institute of Technology · arapyaú · MIT BRAZIL · ie] · AMZ4.0

Manaus team

Dr. Adalberto Luis Val
Researcher at Instituto Nacional de Pesquisas da Amazônia (INPA)

Dr. Estêvão Vicente Monteiro de Paula
Professor at Universidade do Estado do Amazonas (UEA)

Dr. André Luis Willerding
Post-doc. at Instituto Nacional de Pesquisas da Amazônia (INPA)

Lic. Lucas Ribeiro Prado
Bsc. in Law and specialist in Data Science and Big data

Lourdes Falen Horna
Bsc. in Forest Sciences and postgraduate in Ecology

Mentores

Prof. Carlos Afonso Nobre
Researcher at Universidade de São Paulo (USP)

Prof. Maritta Koch-Weser
President of the NGO Earth3000

Some of the content of this document was presented and discussed with professionals from the Arapyau Institute and the Massachusetts Institute of Technology (MIT): Debora Passos, Rafaela Bergamo, John E. Fernández, Brad Olsen, Eduardo Rivera, Griselda Gomez, Brigid McMahan, Rosabelli Coelho-Keyssar and Marco de Paula.

1 CONTENT

2

INITIAL CONSIDERATIONS

The Pan-Amazon now has an estimated population of *50 million* people, which is the result of a population growth that has tripled in the last 40 years. Despite the unparalleled abundance of water, mineral, forest and biological resources, which have been in formation for more than *65 million* years, the Amazon and the peoples that inhabit it, many still isolated in remote areas of the forest, still live in precarious living conditions. Thirty-two percent of them are below the extreme poverty line, and it is not possible to conserve the forest without **social inclusion and the reduction of local inequalities.**

The continental immensity of flowing rivers (*1/5 of the planet's fresh water*), ore deposits (*valued at more than US$ 2.4 trillion*), dense tropical forests (*45 billion cubic meters of standing wood*) and the extraordinary biodiversity (*15% to 20% of the world's biological diversity*), which covers nine Latin American countries, constitute a unique multiplicity of ecosystems and cultures, making every altered or degraded centimeter of the Amazon biome irretrievable. The human being is a fundamental part of this myriad of systemic relationships that form the Amazon.

Adapting the most distinct conceptions of socio-environmental development to the complexity of the Amazon is certainly one of the greatest challenges of humanity and, therefore, it is necessary to include the human being in these conceptions and guarantee their quality of life and the future generations of the peoples of the Amazon. It is not only about conserving the forest as an untouchable sanctuary through monitoring and control, but mainly about creating economic conditions for the development of innovative Amazonian technologies that are capable of accessing and enjoying its natural resources in a socially fair and sustainable way.

In addition to natural resources, the Amazon rainforest offers the planet a variety of environmental services on a daily basis, such as maintenance of biodiversity, water cycling and carbon stocks. These are vital services for the stability of the planet. About 17% of South America's GDP is under the Amazon's zone of influence and much of the world's food production depends on these services. Thus, it is necessary to design mechanisms for adding value to environmental services, and ensure that the Amazon itself and the peoples who live in it are the direct beneficiaries of these green assets and the future of their valuable reserves.

A multitude of information contained in the Amazon has been discovered by science, in such a way that the more we know it, the more complex it reveals itself to be. However, all the scientific knowledge produced over the last 100 years has proved itself insufficient to reduce local levels of social inequality. As long as this information is not socialized and transformed into business, generating employment and income, the socio-environmental crisis tends to worsen and forest conservation is threatened. Therefore, it is essential to restructure the tripod of **science, business and environmental conservation**, and resignify these paradigms in the Amazon context, focusing on the development of the human potential of the region.

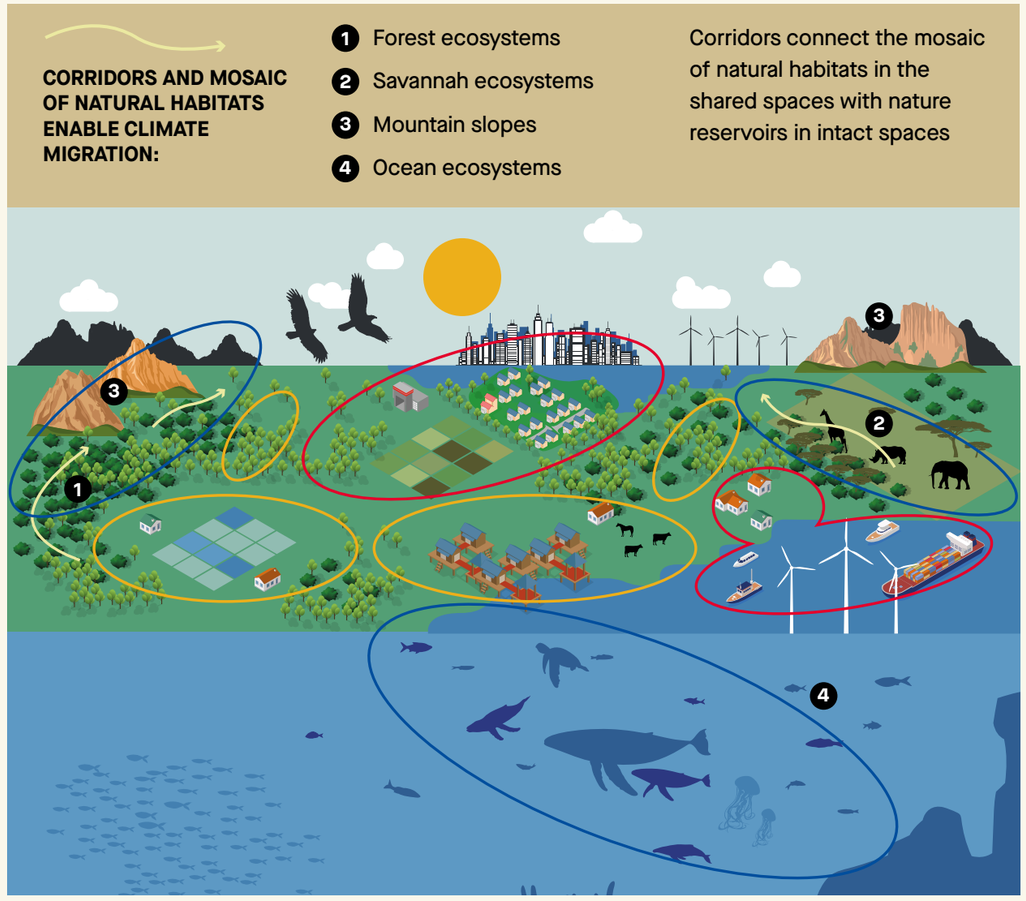
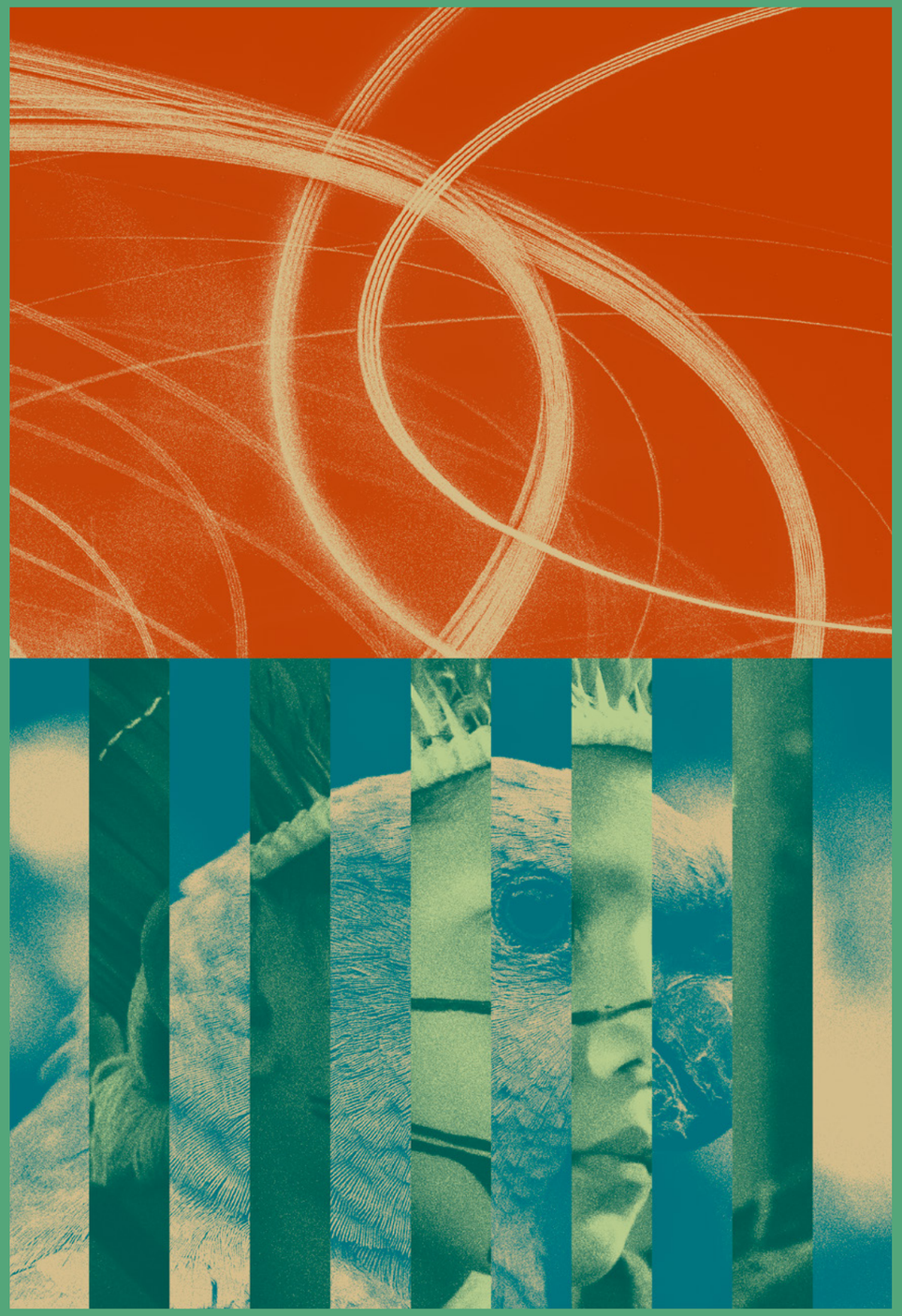


Figure 1. Multifunctional landscapes in terrestrial, freshwater and marine biomes, including large intact wild spaces (blue circles), shared spaces (yellow circles) and anthropic spaces (red circles).

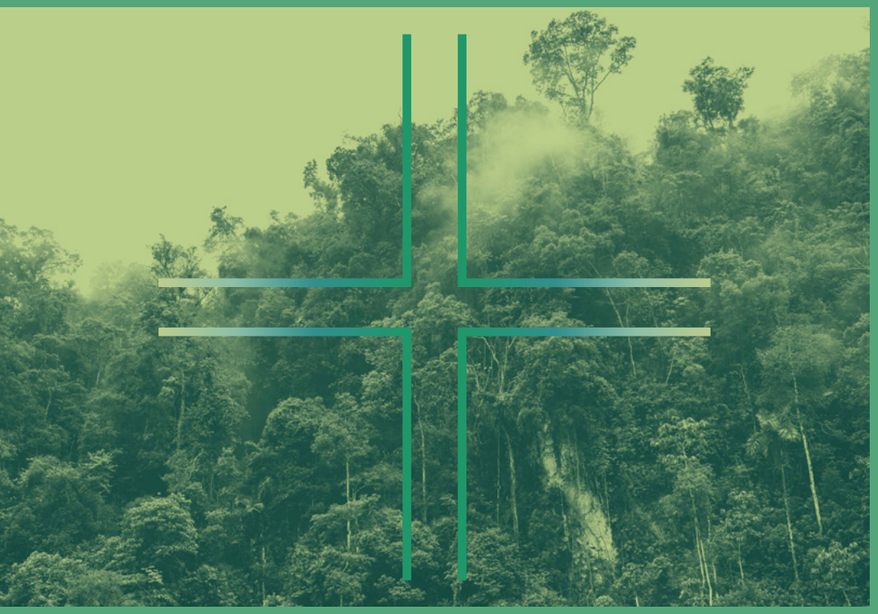
Source: IPCC (2021)

3

INTRODUCTION



The conservation of the Amazon forest comes from the development of society and the reduction of socioeconomic inequalities, especially of local populations, which can be empowered by the expansion of knowledge and from the use of its natural resources. Given the complexity of the Amazon, this is not a trivial activity, and it **requires the effort of institutions at all levels of social organization.** It is essential, therefore, that such an initiative be managed by an institution with *multidimensional and multi-scale capacity.*



There is an urgent need to create an infrastructure in the form of a network that can produce and transform robust information and adapt it to the specificities of the diversity of the Amazon. For this, it is necessary to train personnel; it is necessary to create dialogue with the socioeconomic segments to find solutions for regional problems; and it is necessary to bring to the benches of the laboratories of a local, regional and global network the challenges indicated in the deepest parts of the Amazon. However, more importantly, the results obtained for society must be made accessible and tangible. Therefore, faced with the imposed reality, it is imperative to create an ambitious and innovative project such as the Amazon Institute of Technology (*AmIT*), which has the ability to deal with the challenges of the Amazon in a propitious, efficient and effective way, with the support of sufficient and continuous resources.

AN AMBITIOUS AND INNOVATIVE PROJECT FOR A SUSTAINABLE AMAZON

In early 2020, a collective understanding began to emerge about the importance of creating a **Pan-Amazon institute**, inspired by the Massachusetts Institute of Technology (*MIT*), with the premise that knowledge of the Amazon must be based on science and technology that is directed to innovation in order to ensure socio-economic inclusion in the development of the region itself, while observing the fundamental precepts of environmental conservation.

The idea was conceived by Prof. Carlos Nobre, a researcher at the University of São Paulo (*USP*), together with Prof. Maritta Koch-Weser, president of the NGO Earth3000, who later invited Prof. Adalberto Val, a researcher at the National Institute for Amazonian Research (*INPA*), who were all directly involved with the initiatives that resulted in the present AmIT proposal, initially formulated here with regard to its vision, its mission, its objectives, its components, its viability and its governance. For the elaboration of this pre-proposal, a multidisciplinary team was constituted in Manaus that has maintained dialogue with colleagues from various institutions of the region and MIT.

AmIT proposes to seek creative solutions that involve a holistic and transdisciplinary perspective for the structural problems that result in the sustainable development of the region. That said, the goals and proposals elaborated by AmIT are in line with the current discussions between forest-owning countries and resource donors in the context of global agendas such as COP-26.

VISION

To be a world reference in education, science, technology and innovation that effectively promotes a sustainable and socially inclusive bioeconomy with environmental conservation, through the use of information contained in the Amazon rainforest.

MISSION

Contribute to the socio-economic development and improvement of the quality of life of the population of the Amazon, in synergy with the conservation and valorization of the forest and the rivers through the transformation of scientific and traditional knowledge into technological innovation to serve the Amazon and the world.

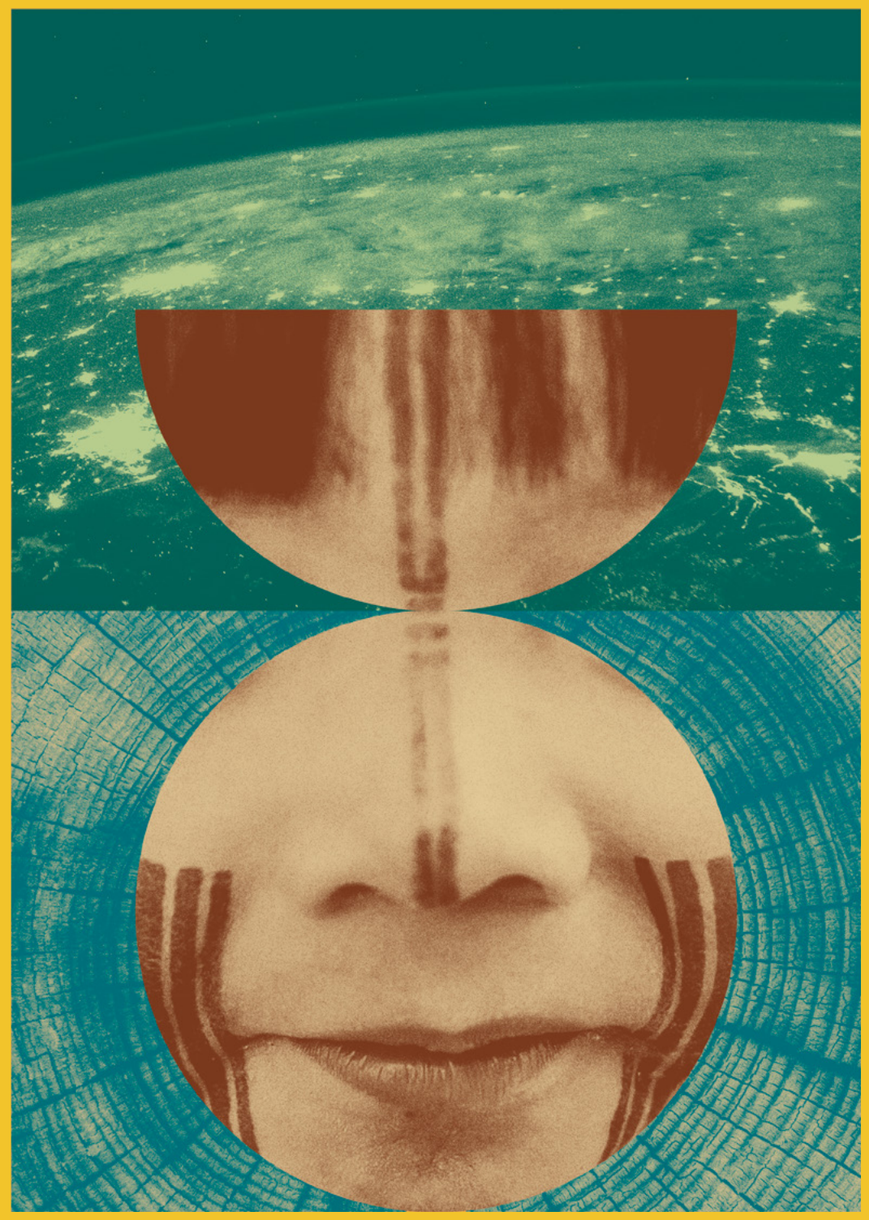
PILLARS

Culture, people, biodiversity, forests and water.

These pillars should consider the foundations expressed by Calvino (1990), namely: **lightness** with the decoding of knowledge in a simple way for understanding society; **agility** with rapid investment for the solution of problems; **precision** with technical and scientific approaches, focused on responding to the great scientific challenges of the Amazon; **visibility** with transparency in actions; **multiplicity** with the considerations of socio-economic multiplurality in the Amazon; and **consistency** with the development of robust studies and research to answer questions that can contribute to the sustainable development of the Amazon biome.

4

GLOBAL AGENDAS AND THE AMAZON



GLOBAL AGENDAS AND THE AMAZON

THE SUSTAINABLE DEVELOPMENT GOALS (SDGS)

There are 17 SDGs, which are grouped into five dimensions: **people, planet, prosperity, peace and partnership** (*Figure 2*). These goals were prioritized in the 2030 Agenda, a global commitment made by 193 countries in 2015. The 2030 Agenda and the SDGs are coordinated by the United Nations (*UN*) and address major contemporary global challenges. The realization of human rights, the promotion of sustainable development and the conservation of the environment through the coordinated action of governments, institutions, academia, companies and the general society are the central objectives.

Figure 2. Living Amazon Vision and the SDGs.
Source: Image adapted from SPA (2021).

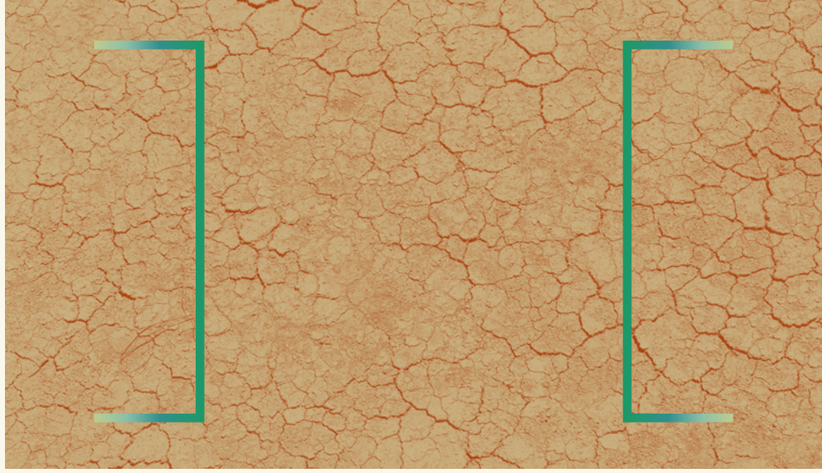
Achieving the SDGs by 2030 would require an estimated increase of around 12 times the global economy (*Woodward, 2015*), which would certainly be unfeasible in the current economic model without the accelerated loss of forests and biodiversity (*Alencar et al., 2021*). Despite the complementarity between the different SDGs, in some cases, the success in implementing a specific objective can interfere or hinder the progress of others (*Katila et al., 2019*).

For this reason, in the case of the Amazon, each dimension must be approached considering the **characteristics of the biome, its people and its culture**. The frameworks, implementation and monitoring of each SDG should consider the role of ecological and cultural capital, means of production and sustainable management of natural resources, access to adequate infrastructure, economic growth, employment and reduction of inequality, among other topics, which are all widely

discussed in the report by the Science Panel for the Amazon (*Nobre et al., 2021*).

Latin American and Caribbean countries, including the Amazonian countries, have faced challenges in identifying indicators of progress in relation to meeting the SDGs (*CEPAL, 2019*). There is a joint effort between the Center for Sustainable Development Goals for Latin America and the Caribbean (*CODS*) and the United Nations Sustainable Development Solutions Network (*SDSN*) to identify new metrics to measure progress in the region (*Alencar et al., 2021*). In general terms, the **progress indicators of the Amazonian countries are stagnating or receding severely**, to the point of making the targets by 2030 unattainable (*Alencar et al., 2021*). Advancing the SDGs requires strategies and investments to boost technological innovation initiatives and strengthen value chains that result in sustainable development for the region (*Gonzalez-Perez et al., 2021*).

On the other hand, world scenarios call attention to actions that promote peace and planetary resilience. The latest global events have awakened the world to the fact that the sovereignty of nations depends not only on the military capacity of each one, but on the autonomy of the production of goods, such as inputs for health. Biodiversity, for example, can help with the search for new substances and examples of natural interactions that enable human resilience in the face of zoonotic challenges that threaten the planet. Planetary resilience and peace also depend on the neutralization of conflicts that can be mediated by what the forest, rivers and their native peoples can teach.



THE CONFERENCE OF THE PARTIES

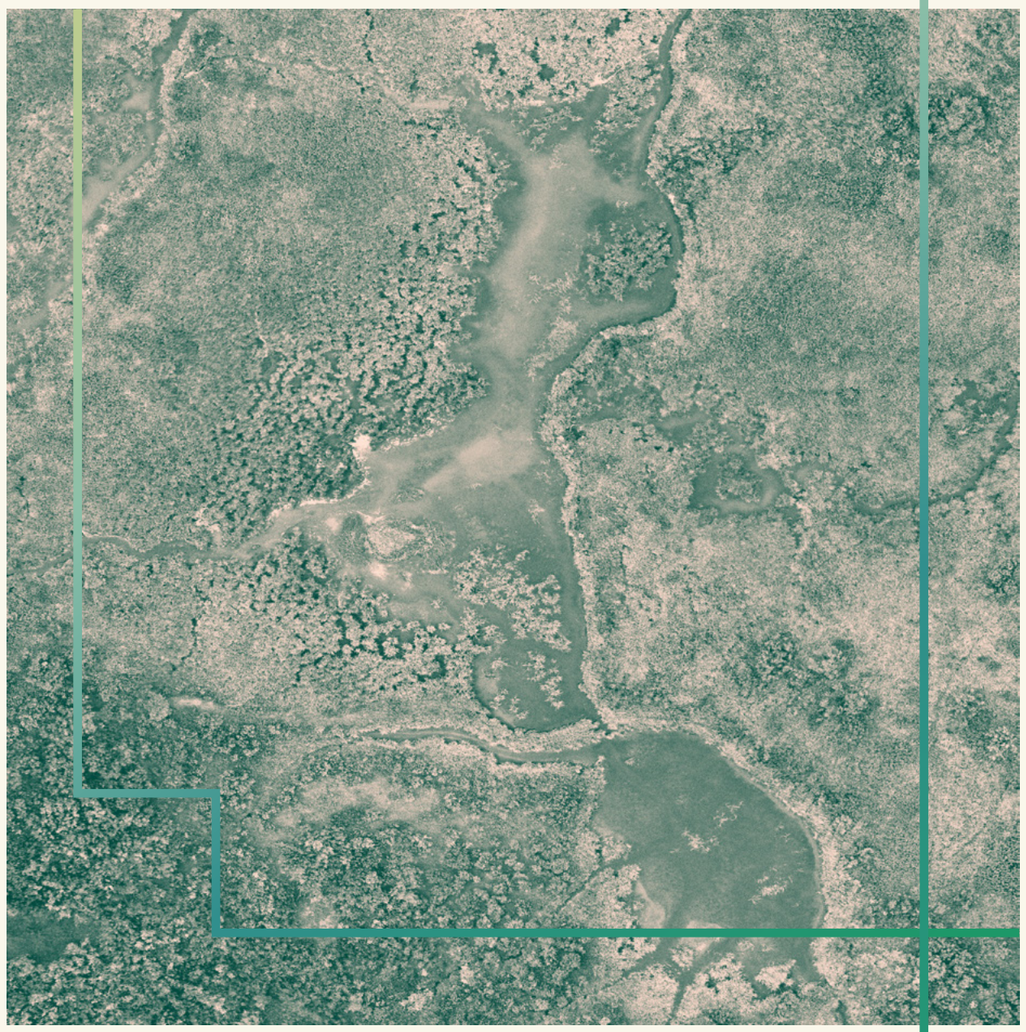
The Conference of the Parties (*COP*) is the supreme body of the United Nations Framework Convention on Climate Change, which was adopted in 1992. In this treaty, countries agreed to stabilize greenhouse gas concentrations in the atmosphere. In 2021, COP-26 was held in Glasgow, Scotland, by which the countries present signed an agreement to ensure compliance with the goal of limiting global warming to 1.5 °C.

Compliance with this agreement is imperative since it represents the **last opportunity to reverse the process of the global emergency caused by climate chang**e. According to the sixth report by the IPCC Working Group I, the world is likely to reach or exceed 1.5 ºC of warming over the next two decades. Thus, the future of the planet depends on the actions carried out in this decade (*IPCC, 2021*).

The Amazon rainforest contributes to climate balance by capturing and storing carbon dioxide (*CO2*) in the formation of plant tissues. Cleared or burned forest releases some of the gases into the atmosphere, increasing the concentration of greenhouse gases. Recent studies indicate that the eastern part of the Amazon is 30% deforested and emitted 10 times more CO2 than areas with deforestation of less than 20% (*Gatti et al., 2021*). This imbalance can reach the so-called tipping point, which means that degradation, climate change, fires and anomalous drought events will irreversibly change the Amazon rainforest (*Lovejoy & Nobre, 2018*).

Therefore, the role of the Amazon in the context of climate change is crucial to the success or failure of the goals flagged during COP-26. Finally, the world is recognizing the imminent dangers facing the Amazon. During COP-26, different public and private sources pledged over US$ 10 billion for this cause, with more funding to be mobilized soon (*Nobre et al., 2021*).

To date, national and international environmental laws and conservation efforts have failed to reverse deforestation and forest degradation in the Amazon. The revolutionary and unprecedented vision that AmIT proposes is urgent and necessary. The challenge lies, above all, in social empowerment, with the maintenance of forests and rivers, with the restoration and rational use of deforested areas, to devise new strategies for social inclusion, education, health, personnel training and income generation.



CONSERVATION FOR HUMAN EMPOWERMENT

AmIT focuses on the people of the Amazon in the search for sustainable development in the region. This is done by adopting the following action strategies:

a) decentralize science and technology from the capitals of the states of the Amazon to other municipalities. The locus of effective operation takes place directly in the areas of study interest, with the support of local society, local institutions and highly specialized researchers and technicians for problem solving;

b) take advantage of natural resources as economic alternatives for social inclusion and conservation of the biome. In this context, it includes the strengthening of value chains with identified markets;

c) transform the environmental liabilities of degraded and altered areas into environmental assets according to their edaphoclimatic conditions;

d) propose the implementation and improvement of infrastructures to solve the logistical challenges within the Pan-Amazon;

e) design mechanisms for sustainable businesses that transform the Pan-Amazon into a global reference in bioeconomy;

f) contribute to public policies for the adequate use of natural resources in the Amazon.

The solution of the gigantic challenge that AmIT will face is only possible with the **implementation of a constellation of centers of excellence distributed in homogeneous form in the Pan-Amazon.** Thus, the regional intelligence units (*RIUs*) will be connected to a network consisting of knowledge-producing institutions and universities, with the participation of MIT. ■

5

DEVELOPMENT AND STUDY CENTERS

AmIT – Amazon Institute of Technology

DEVELOPMENT AND STUDY CENTERS

AmIT contemplates the creation of **development and study centers** dedicated to the priority issues for the Amazon, which are particularly neglected from an innovative and integrating perspective, thus differentiating itself from traditional research institutions. It is planned to create five development and study centers, namely: *Amazon Waters, Forest, Altered Landscapes, Urban Amazon and Smart Mining.*

1. Center for the Development and Study of the Waters of the Amazon

The Amazon basin has been essential for the well-being of people since the beginning of its occupation. Rivers and associated ecosystems influence the life of human populations in aspects ranging from food supply to socioeconomic connections through river transport. The negative impacts of anthropogenic activities affect aquatic ecosystems and make biodiversity conservation, integral health and food security vulnerable. In this sense, the biology of the freshwaters of the Amazon is fundamental for the **development of technologies for the management and use** of water resources in the region.

Due to the importance of aquatic ecosystems and Water Resources, The Center for Development and Study of Amazonian Waters aims to identify issues and challenges related to these environments. The study of biodiversity, monitoring and actions to improve the connectivity of environments will be one of the priorities. The center will promote the monitoring of diseases and zoonoses propagated by alterations in water quality and river regime. In addition, technology and innovation will be the basis for optimizing the use of water in food production, production of alternative energy sources, improvement of infrastructure and efficiency of river transport.

With these actions, AmIT hopes to contribute to the socio-economic integration of Pan-Amazon member countries, ensuring and improving access to health, food security and alternative energies. To this end, it is proposed to create networks with institutions that work on priority health issues; for example, the Amazonian Center for Tropical Diseases, in Venezuela; the Oswaldo Cruz Foundation (*Fiocruz*), creator of the Wildlife Health Information System (*Siss-Geo*), The Tropical Hospital of Manaus, in Brazil, among others. For matters related to technological innovation in the construction of vessels, infrastructure and alternative energy supply systems, a very close interaction with MIT will be sought. Below, we detail, uniquely and specifically, the interactive conjuncture of this center with different areas.

2. Center for the Development and Study of the Forest

The Amazon biome is a global biodiversity hotspot, where a new species is discovered every two days. In addition, there are organisms such as fungi, algae, bacteria and viruses that are still sparsely studied. The information and processes that maintain this biodiversity are little studied and explored, particularly to generate knowledge that drives sustainable socio-economic development of the region.

The conversion of the natural resources of the Amazon in order to make **productive and financial sustainability** possible needs the transformation of the traditional model of economic development. It depends on science and technology. From a pragmatic point of view, lack of the use of existing information in new technologies to add value to natural resources is disastrous for environmental conservation, social inclusion and income generation. In other words, the old extractive model does not contribute to the maintenance of forest and to the flowing of the rivers.

This new economic model, linked to regional vocations and not resulting in the reduction of natural resources, involves the emergence of complex networks between companies, academia and governments. The Center for Development and Studies of the Forest will drive the use of advanced technologies for the physical and functional study and monitoring of forests and aquatic ecosystems.

In addition, AmIT will prioritize the research of natural resources with potential for strengthening the Amazon value chains, through the prospecting of new forest assets with potential for the bioeconomy/biotechnology. In addition, the socio-ecological wealth of the Amazon will be an important axis for the construction of new business models with the participation of indigenous and traditional peoples.

With these actions, the center will be able to promote the expansion of knowledge, still scarce, about **sociobiodiversity** and its potential to be inserted as part of the promising scheme of the bioeconomy and green business. In this way, it is expected to strengthen the value chains that guarantee the generation of income of the Amazonian peoples through small and medium-sized companies from the strategic sectors of ecotourism, renewable energy, and biorefineries, among others.

AmIT will create partnerships with prominent Amazonian institutions, such as, for example, the Research Unit of Ecology of Guianan Forests (*Ecofog*) of French Guiana, which has highly conserved forests; the Instituto de Investigaciones de la Amazonía Peruana (*IIAP*), which has been developing genetic studies of fish with ornamental potential; the Instituto Nacional de Pesquisas da Amazônia, a world reference in studies on biodiversity and the use of the natural resources of the Amazon; the Instituto Nacional de Pesquisas Espaciais (*INPE*), for monitoring the functioning of forests in relation to anthropogenic activities and climate change, among other institutions of the countries of the Amazon.

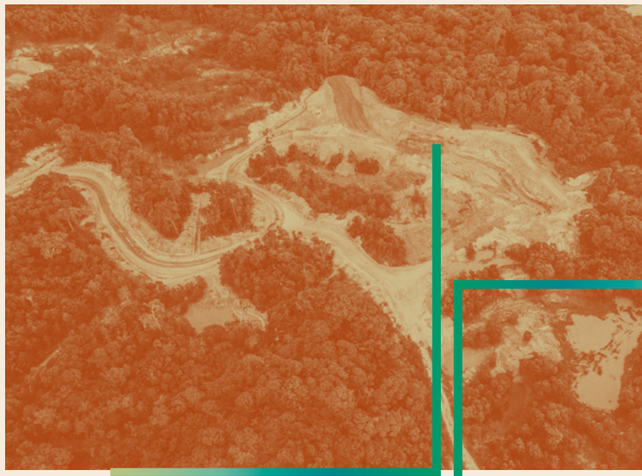
3. Center for the Development and Study of Altered Landscapes

Among the current challenges is the need to develop models that take advantage of the altered areas existing in the Amazon. The correct use and reuse of altered areas will contribute significantly to the **food security** of the world's population and the maintenance of the environmental services that the forest can offer. In this way, it will be possible to ensure the development of the region without generating deforestation and forest degradation.

The Center for the Development and Study of Altered Landscapes must integrate the economic, social and environmental dimensions to generate an input and attract investment in technologies that allow the use of natural resources in a sustainable way. It is a low-carbon economy combined with new sustainable patterns of consumption and production. This is in line with the world scenario, international environmental commitments and recent legislative changes in Brazil and other Amazonian countries, and has positively impacted the valorization of forests through integrated use for conservation. These trends, coupled with the recovery of altered areas, offer sustainable business opportunities within a green economy, ensuring the balance between economic growth, environmental conservation and social welfare.

AmIT will aim to increase the **economic density** of the forest with as little environmental impact as possible. The reuse of the altered areas should be made based on thorough analysis of the characterization, objectives and history of use of the area. Among the possible alternatives are agroforestry systems, forest enrichment using tree species of economic interest (*andiroba, copaiba, rosewood, and Brazil nut, among others*) and growing of the fruit of domesticated and improved species (pineapple, banana, watermelon).

In addition, the altered and reforested area can be turned into an "asset" for the payment of forest environmental services. To achieve these objectives, AmIT will seek to generate connections with important institutions of the Pan-Amazon, such as, for example, the Empresa Brasileira de Pesquisa Agropecuária EMBRAPA, the Instituto Amazónico de Investigaciones Científicas SINCHI, in Colombia and the Instituto de Investigaciones Amazônicas, in Bolivia, which all stand out for their research on sustainable productive systems and forest enrichment.



4. Center for the Development and Study of the Urban Amazon

The Amazon has a strong urban component characterized by the displacement of people from rural areas to the outskirts of cities. In the Brazilian Amazon, close to 80% of the population inhabits cities and many suffer from lack of sanitation services, are vulnerable to floods and river pollution, live off underemployment and in an environment of violence (Brondizio, 2007). Fifteen years after the study by Brondizio, this scenario still exists. In addition, the conventional architecture and the current energy matrix in the Amazon are incompatible with the environmental reality of the tropics. These issues are undervalued in discussions about the future of the Amazon, and the rural and urban populations depend on the services and functions of the forests and rivers.

The Center for Development and Study of the Urban Amazon will prioritize the collection of primary information and the **monitoring of the interface of urban areas with the forest**. These activities should include the comprehensive health of the complex environment-animals-people and vulnerability to environmental and climate change. The center will promote mapping and contribute to the strengthening of the main value chains based on the multi-localized family structure, i.e., involving family members distributed in rural areas and in the peripheries, as a strategy to increase family income. It will also enable research on materials, bioclimatic construction techniques and the use of alternative energy sources. The research should integrate the knowledge of local populations and the use of advanced technologies for the design of cities visually and functionally integrated with the Amazon landscape.

The research proposals of this center also aim to detect potentially infectious agents and zoonotic outbreaks in the population, in order to enable rapid actions for control. Strengthening value chains can increase **income generation** and improve quality of life. Similarly, with the studies and modeling of environmental vulnerability, we seek to alert the population about environmental disasters that may happen in a certain place. The reduction of inequality is expected to also reduce vulnerability to violence and delinquency, especially in the younger population. In addition, it seeks to rethink the design of urban infrastructure considering the climatic characteristics of the Amazon and efficient use of energy.

To achieve these goals of the Center, AmIT will stimulate the participation of institutions such as IDESAM, a Brazilian NGO dedicated to strengthening Amazon value chains and the Universidad Amazónica de Ecuador (IKIAM), which works with materials research and development of sustainable architecture and construction technologies, among other institutions of the Pan-Amazon, to together provide solutions to the issues of the urban Amazon.

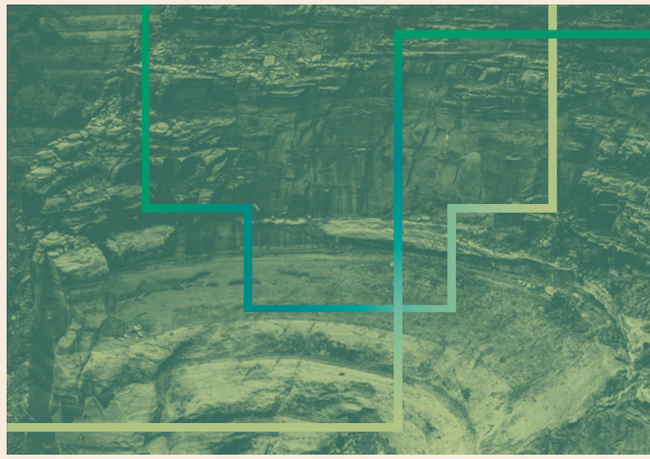
5. Center for the Development and Study of Smart Mining

The use of mineral resources has been essential in the development of humanity from its beginnings to the latest-generation technologies. The Amazon has mineral potential that has been little explored (*Cordani & Juliani, 2019*). Commonly, illegal mining causes devastating impacts on the health of the environment and local populations, and has even intensified the vulnerability of indigenous communities and minority groups. In this scenario, there is an urgent need to promote initiatives for **organized mining that is transparent and has low social and environmental impact.**

AmIT will operate on two main lines regarding mining in the Amazon. The first will aim to research and develop efficient technologies and systems with low environmental impact in the extraction, processing, transport and distribution of minerals in order to strengthen the value chains of mining products. The second line will develop knowledge for the remediation of contaminated soils and treatment of rivers polluted with toxic effluents, which are the result of harmful practices used in illegal mining, thus contributing to the recovery of already degraded areas and seeking to recompose the integral health of the populations that inhabit these areas.

With these initiatives, it is hoped to change the negative view of mining in the Amazon, which is one of the last frontiers of mineral wealth in the world. It has already been shown that smart mining can deliver large revenues in reduced spaces. This, added to the reduction of environmental impacts, makes this activity an environmentally safe alternative, which would enhance the value chains in the Amazon and, consequently, improve the quality of life of people, though without harm to the integral health of the biome. Mining that is conceived from the aforementioned principles can contribute to the eradication of socio-environmental problems related to illegal mining in the Amazon, which includes, among others, homicides, prostitution, human trafficking and drugs. Finally, illegal mining in the Amazon needs to be banned and replaced by practices that involve social inclusion and environmental conservation; therefore, it needs to be under continuous monitoring by society.

Regarding this theme, AmIT will promote partnerships with institutions such as the Instituto de Geociências at the Universidade de São Paulo (*IGs/USP*), which develops projects to improve mining technologies and laboratories and nurseries of the Vale do Rio Doce company, in Brazil, and the Centro de Innovación Científica Amazónica (*CINCIA*), which acts in remediation of areas degraded by illegal mining in the Peruvian Amazon, among other institutions of the Pan-Amazon.



Details of the Center for Development and Study of the Waters of the Amazon

Since the elevation of the Andes 65 million years ago, water has been the engine of life in the Amazon biome. The Amazon basin is home to the largest river, which carries more water than any other river (~220,000 m3/s) and has been essential to the well-being of peoples since the beginning of their occupation. Currently, Amazonian human populations continue to live in a **close relationship** with waterbodies. Rivers and riparian areas influence the lives of local populations and humanity in general, in **multiple and interconnected ways**. The conservation of biodiversity and its ecological functions, and the improvement of people's quality of life through improved health, food, transport and energy supply are the main challenges of sustainable development in the Amazon region. Given the importance of freshwater ecosystems and their overlap with terrestrial and seasonally flooded landscapes, there is an urgent need to identify the main issues and challenges related to these environments. Targeted solutions to improve water use in the Amazon are essential for the sustainable development of the region and for the good of humanity.

BIODIVERSITY

The Amazon is home to 14% of all tropical birds, 9% of all mammals, 8% of all amphibians and 15% of the world's freshwater fish. However, biodiversity is declining much faster than in oceans or forests due to anthropogenic disturbances in rivers (*Nobre et al., 2021*). Direct factors that promote the degradation of the Amazon biome include **changes in the physical regime** through the installation of dams and other constructions that affect flow and connectivity between habitats. In addition, poorly planned livestock, agriculture, logging and mining activities change the chemical characteristics of the waterbodies and adjacent environments, thereby affecting the natural cycles of living organisms. Thus, the conservation and sustainable management of rivers and adjacent environments are essential for the conservation of biodiversity and the protection of the livelihoods of the people who depend on them. The recent IPBES-IPCC report clearly shows the importance of integrated management of all environmental sectors, as all of them and their use synergistically affect each other.

HEALTH

Amazonian populations live near freshwater ecosystems and their well-being depends on maintaining the health of the environment. Any disturbances in water quality and the flood regime can increase the spread of **waterborne diseases and zoonoses**. In addition, there is evidence that forest loss can drive and spread tropical diseases. These critical issues affect more remote areas of the Amazon basin, where people have little or no access to basic health systems. On the other hand, industrial and urban pollution in rivers also puts human health at risk. In fact, the system should be approached as a global health system.

FOOD

Rivers are one of the most productive ecosystems, and **fishing** provides Amazonian peoples with the main source of protein. In addition, water is the basic input for food production. Ecosystem services require the maintenance of fundamental characteristics and processes in freshwater ecosystems. However, industrial impacts and climate change put food security at imminent risk. The traditional food production system uses almost 70% of all fresh water extracted for **agriculture**. There is a growing recognition of the interdependence between water, energy and food security (*Carmona-Moreno et al., 2021*); however, the development of technological alternatives in sustainable food systems is scarce in the Amazon.

TRANSPORT

The integration of Amazonian countries is fundamental to **facilitate mobility** and business on an intra-and extra-continental scale. For this, it is possible to take advantage of the interior areas of border interchange. Carreiteiro (*1987*) divides these areas into three: The Negro-Branco system that integrates Brazil, Guyana and Venezuela; the Solimões-Juruá-Içа-Putumayo, Napo, Marañón, which covers Brazil, Colombia and Peru, and the Madeira, Guaporé system that connects Brazil, Peru and Bolivia. These areas allow the integration of the Amazon and Prata waterways.

Inland navigation is relevant for the integration and socio-economic development of Amazonian countries. Although rivers have allowed the connection between the Amazonian populations, transport logistics is incipient to this day. Canoes, boats, speedboats, ferries and ships are the main means of transport since the colonization of the Amazon. The traditional knowledge of vessel construction, added to the use of advanced technologies and innovative designs, will make river transport attractive, light, fast and efficient, which are characteristics necessary for the improvement of the Amazon value chains.

Each river has peculiarities in the seasonal dynamics and the level of its waters. Therefore, it is necessary to develop port designs adapted to the particularities of the rivers and the services they will offer to the populations. These projects should transform the large rivers into waterways with correct markings, updated cartographic support, modern communication systems and dissemination of river routes, lighthouses, and radio aid, among other relevant information. The improvement of river transport and its connections with other means of transport should reconcile socio-economic development with the conservation of wildlife, and promote alternative energy sources and adequate management of effluents.

ENERGY

Energy production is a **limiting factor** for economic growth in the Amazon region. Although water has been used as a source of renewable energy, large and poorly designed hydroelectric dams can be more harmful than thermoelectric ones, in terms of greenhouse gas emissions. Dams can also block access to habitat and interfere with wildlife movement, increasing habitat fragmentation and disrupting the life cycles of fish and other species (*Agostinho et al., 2016*). Considering these observations, it is necessary to plan alternative technologies that use water as an energy source.

To date, we have detected five priority fields related to water resources that require collaborative efforts in the Amazon basin. While we treat biodiversity, health, food, transport and energy as separate topics, there is a clear overlap between them. Traditional development models are not adequate for meeting the unprecedented challenge of improving the quality of human life and the conservation status of the world's largest rainforest and river.

The Amazon Institute of Technology (*AmIT*) proposes the creation of the "Center for the Development and Study of Amazonian Waters" to conduct specific and efficient actions to fill knowledge gaps through a multidisciplinary and transversal approach: the exploration, use and conservation of biodiversity and freshwater resources through science, biotechnology and the bioeconomy to improve the quality of life of people.

Expected actions and results

The "*Center for Development and Study of Amazon Waters*" will carry out the first actions related to the main issues and gaps mentioned in the five fields previously described in order to achieve positive impacts following the nine core components of AmIT.

AREA	ACTIONS	IMPACT
Biodiversity	Design and support the adoption of a science-based aquatic biodiversity management program that involves conservation strategies (e.g., creation of ecological corridors and buffer zones such as land and water passages to establish a permanent connection between larger areas to facilitate the dispersal of animal and plant species).	Environmental sustainability
Health	Development of technologies and their socialization to monitor zoonoses, waterborne diseases and chemical accidents. Prospection of molecules in Amazonian aquatic environments that have pharmacological applications and can be used for environmental recovery.	Improving quality of life
Food	Food development and socialization of water-based technologies for food security and sustainable use of water and energy in the food industry.	Improving value chains
Transport	Food development and socialization of water-based technologies for food security and sustainable use of water and energy in the food industry.	Improving value chains and improving quality of life
Energy	Energy development and socialization of alternative, equitable and efficient ways of generating, distributing and storing energy from water. Development of adequate hydropower systems to preserve the interactions of fauna and flora with water bodies.	Creative solutions and environmental sustainability

Table 1. Actions and expected impacts of the Center for Development and Study of Amazon Waters

The Water Center is a clear example of the need to operationalize the ideas discussed in this document. The disorganized growth of the urban frontier, which intensifies social differences and decreases people's quality of life, and the increase in deforested or altered areas used for unsustainable purposes, is one of the many challenges facing the planet, including the Amazon. However, the eyes of the world are on the Amazon because its still little explored immense potential constitutes the "panacea" for problems in the current world. AmIT aspires to be the driving agent of these great changes, first, in favor of the well-being and empowerment of the Amazon and its people, and then to offer solutions to the whole world.

Connection between the five centers and the nine components

The five planned centres will work together on the challenges envisaged in the different components listed below, including their priorities. Thus, the need arises to establish structuring actions that will have transversal participation in each of the development and study centers mentioned in this section. In Figure 3, we show the interaction between the centers and the nine components that will be detailed in the next section. ■

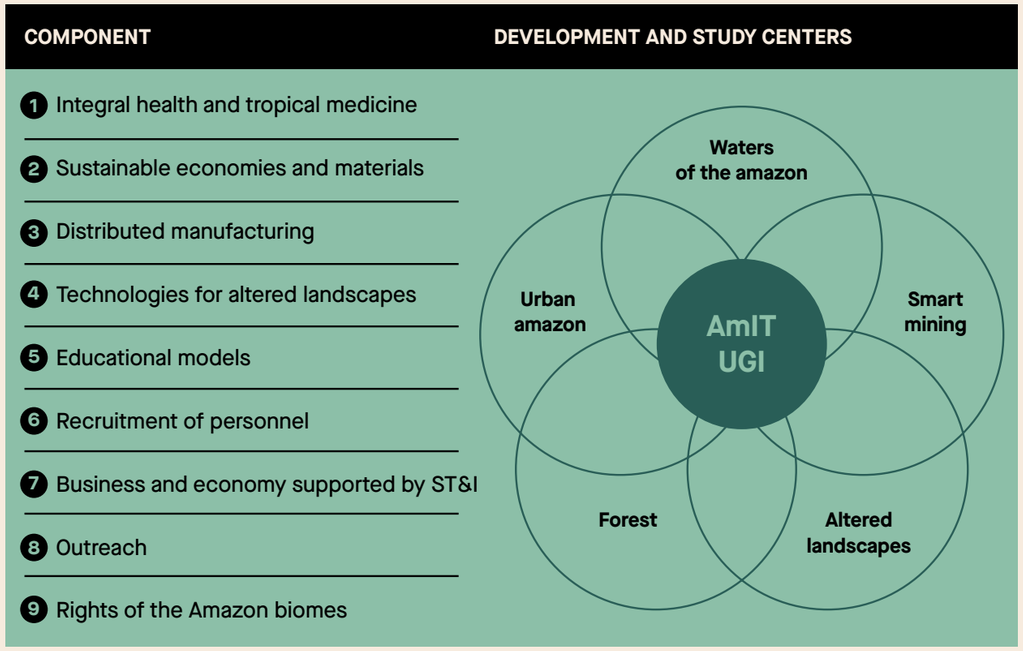


Figure 3. AmIT components targeted through development and study centers.

6

STRUCTURING COMPONENTS OF AmIT

AmIT – Amazon Institute of Technology

STRUCTURING COMPONENTS OF AmIT

AmIT includes **nine components** prioritized for the launch of a new research and education scheme focused on the technological and economic development of the Amazon. These components were identified according to the professional experience and extensive knowledge the team members possess regarding the reality of the Amazon and following the *problem-oriented and solution-oriented thinking* methodologies (*Figure 4*). These methodologies are strongly linked to critical thinking in the formulation of problems and potential solutions through creative strategies.

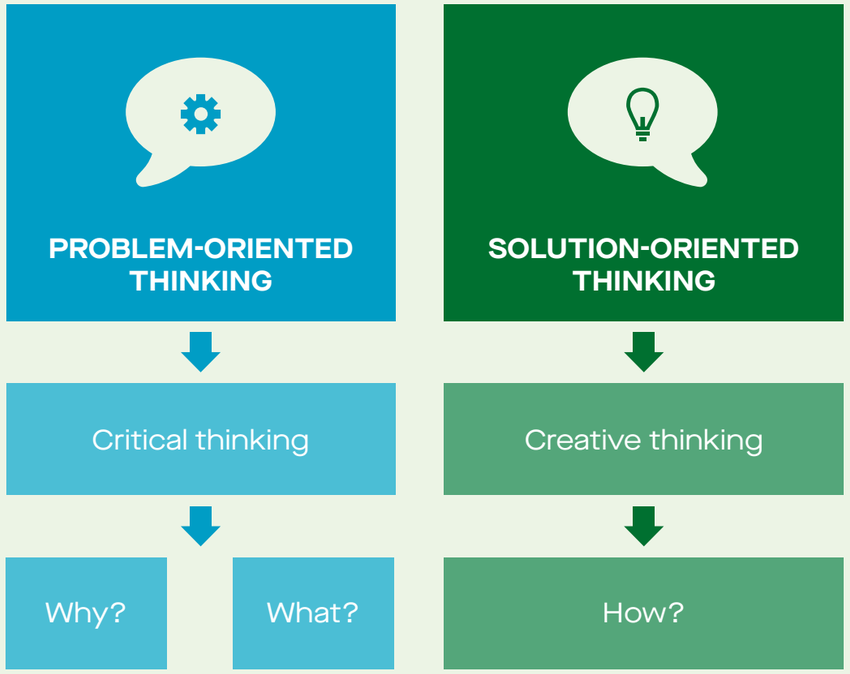


Figure 4. Methodologies used to identify the nine components of AmIT
Source: adapted from Pusca & Northwood (2018).

The following are the nine structuring components of AmIT. Each of them includes a brief contextualization, the objectives that have been set, the priority actions to achieve them and the specific implementation strategies.

Component 1

INTEGRAL HEALTH AND TROPICAL MEDICINE

Context

The Amazon plays a central role for the integral health of the planet. The disordered population growth in urban areas, associated with the uncontrolled expansion of agricultural frontiers, have caused a strong imbalance in the set of relationships that sustain the health of the Amazon biome, including human health. Neglected Amazonian diseases such as malaria and leishmaniasis, which predominantly affect areas with a low human development index, are a critical symptom of this socio-environmental imbalance. It is essential, therefore, that AmIT's actions are aligned with the improvement of quality of life from the perspective of integral health in the Amazon biome.

In the indigenous worldview, the Amazon is seen as a key entity. For indigenous and traditional peoples, health conceptually includes the social, political, spiritual and physical well-being, not only of the individual, but of the community and the ecosystem (*Alexiades, 1999*). For this reason, the urban health approach is seen as lacking connections by riverine and traditional populations. These populations tend to resort to conventional health services only in more severe cases; many of the diseases are treated in the community itself. Even when the health care system becomes the last resort, the structures available for surgeries, examinations or medical treatments are precarious, obsolete, distant or nonexistent.

The riverine and traditional populations are dispersed in the vast Amazon territory, which, added to the precarious prevention and health promotion networks, leave them more isolated and in conditions of high vulnerability to eventual health disasters (*Canalez et al., 2020*). An example of this, is the disproportionate impact caused by the COVID-19 pandemic in the Amazon compared to other regions (*Codeço et al., 2020; Larrea-Alcázar et al., 2021*). As such, unequal access to health services and vaccines is creating even more inequality among countries in the region (*CEPAL, 2021*).

Amazonian peoples are fundamental in the conservation and restoration of Amazonian ecosystems, despite the impacts of violence, conflicts and diseases that have increased significantly in recent decades (*Athayde et al., 2021*). The biocultural landscapes managed and conserved by the Amazon communities provide essential environmental services for global food security, climate stability and bioeconomy, which could also help to deal with health crises (*Flores & Levis, 2021*). In this conception, people's well-being is supported by integral health (*Wali*

et al., 2017). This new paradigm for humanity, integral health, is not limited to the Amazonian countries; it permeates all the inhabitants of the planet, as well as future generations and different species that depend on the existence of the Amazon biome.

Recent research shows that forest degradation is associated with unsustainable economic activities of high environmental impact, which involve the felling and burning of the forest, which causes an increase in the transmission of infectious diseases, particularly zoonotic diseases (*Ellwanger et al., 2020*). To better understand this phenomenon, researchers have developed

algorithms for modeling the occurrence, for example, of malaria in the region (Braz et al., 2014). The monitoring systems for disease in wildlife should also be mentioned, such as, for example, the "Wildlife Health Information System", which has the collaboration and participation of local communities (*Amazon Sustainable Landscape Program, 2020*).

In the current climate change scenario, in which interactions between humans, animals, plants and the environment are accentuated, health problems become increasingly recurrent, reinforcing that everything is intrinsically interconnected. The COVID-19 pandemic, the resurgence of infectious diseases, the loss of biodiversity and the reduction of their biological functions are some chronic symptoms that need to be understood and treated under the holistic perspective of integral health.

There is an urgent need to build effective, equitable and resilient health policies with the premise of recognizing the importance of environmental health in people's well-being and vice versa. Agricultural borders and urban areas bordering the forest are risk zones for the emergence of new diseases and spread of viruses such as dengue, Zika and chikungunya. The degradation of forests brings not only the deterioration of the quality and functionality of the environment, but also socio-economic problems that affect the health of millions of people in the Amazon and compromise the quality of life of these and future generations (*Berenguer et al., 2021*).

From the context described above, AmIT proposes the following objectives for this component:

· Outline an action panel for the use of S&T (science and technology) in connection with the mission and objectives of AmIT in promoting the health and well-being of the Pan-Amazon population.

The strong integrative, transversal and transnational character of integral health makes this component a guide to move consistently towards the other components. After all, without guaranteeing well-being and quality of life in the Amazon, any action in the area of ST&I is unsustainable. Definitely, integral health and Amazon are inseparable elements — one cannot sustain itself without the other.

· Identify and strengthen a network of cooperation to ensure food security and produce information for the control of current and potential zoonoses, the fight against neglected and transmissible Amazonian diseases and the emergence of antimicrobial resistance in the Amazon.

The Amazon biome is home to an immense range of zoonotic viruses that are potentially transmissible to humans, as well as pathogens hostile to plants, which could affect not only agricultural crops, but the Amazonian fauna itself. For largely unknown taxonomic groups, such as fungi, basic research activities are still necessary (*Maia et al. 2015*). Fungi are an important source of bioactives that can lead to new drug discoveries (A*lmeida, 2014*).

· Establish and coordinate an effective communication environment to promote the sustainability of public health actions for the Amazon population.

The consolidation of an inclusive and integrative health system, which is compatible with the continental dimensions of the Amazon, depends on the convergence of efforts of private institutions, public entities at different levels, health surveillance agencies, national health agencies, multilateral organizations and non-governmental organizations in order to ensure the continuity of public policies and avoid scattered, overlapping and fragmented actions.

© Ben Sutherland

Implementation strategies

The demands that are necessary to promote an integral health environment in the Amazon constitute a challenge for the implementation of actions, strategies and policies, especially to protect the most vulnerable populations (PAHO et al., 2018). The collection of information and monitoring of the infrastructure of services that affect health, combined with analysis and prevention of environmental and socioeconomic impacts, needs a multidisciplinary approach in which datascience, tropical biomedicine, environmental engineering, animal science, phytopathology, infectology, microbiology, molecular biology, mathematical modeling, social and economic sciences are tools to compile and create knowledge applied to the improvement of well-being in the Amazon.

To enable integrative public health policies focused on improving quality of life and guided by the multiple connections between health, society and the environment, it is necessary to compose a supranational organization. AmIT will stimulate the composition of this organization, cooperating with the interaction between public entities. This body must bring together those responsible for the areas of health, basic sanitation, environment, science and technology in each Amazonian country in order to allow

the articulation and integration of planning and territorial planning instruments.

Through AmIT, this organization would be connected and supported by the main regional, national and international scientific research reference centers, among them the Fundação de Medicina Tropical Doutor Heitor Vieira Dourado, Fundação Oswaldo Cruz (*Fiocruz*), Fundación Enlace Hispanoamericano de Salud, Centro de Investigación para la Salud en América Latina, and Instituto de Servicios de Laboratorios de Diagnóstico e Investigación en Salud da Bolívia. Thus, it is expected to incorporate scientific knowledge to public policies in the Amazon, aligning them with the conception of integral health, in order to promote social inclusion, protection of ecosystems and mitigation of pressure on natural resources.

Another crucial factor is to promote the broad socialization and decoding of scientific knowledge to implement solutions to Amazonian health problems. Databases (*big data*) that are capable of integrating, storing, processing and crossing primary information generated by the various hospital units, basic health units, health agents and health surveillance agencies distributed throughout the region, are strategic for the development of efficient predictive models to, for example, identify and prevent new zoonoses. In addition, state-of-the-art genomic technologies such as environmental DNA (*eDNA*) have a wide spectrum of application, including for reacting to large environmental accidents (*Santos et al., unpublished data*).

The activities of the AmIT must therefore be permeated by local realities and ethnocognition. The search for solutions to anachronistic socio-environmental problems, such as neglected tropical diseases, must better understand their correlations with extreme weather events, increasingly recurring in the region. In this sense, it is necessary to develop health indicators for the evaluation and monitoring of issues such as food security, access to water, decent housing, security and spirituality (*Verschuuren et al., 2014*). A collaborative digital platform adapted to local particularities would have the important function of absorbing and disseminating reliable information that could be used by society in the prevention and remediation of health-related problems.

In summary, implementing integral health in the Pan-Amazon requires systematic and integrative planning for the creation of a decentralized network of biological samples, diagnostics, georeferenced data, technologies for strategic monitoring of zoonoses, scientific research and socialization of knowledge in the various areas of human and environmental health so that the necessary actions are effected quickly and homogeneously in the region.

Priority action: Integral health environment for the Amazon

WHAT?

Development of a database for monitoring emerging zoonoses and food security, integrating and sharing knowledge among Amazonian stakeholders.

HOW?

Use of molecular technologies for monitoring potential new zoonoses; database development; and connection with artificial intelligence technologies for monitoring emerging zoonoses and food security.

WHERE?

Identification of research groups of excellence, formation of cooperative networks and socialization of information.

Component 2

SUSTAINABLE ECONOMIES AND MATERIALS

IN TERRESTRIAL AND AQUATIC FOREST ECOSYSTEMS

Context

The economic potential of the Amazon is immeasurable, as is the vast set of endemic species of plants, animals, insects, fungi, bacteria and viruses that exist in the forest, which is described all the time. The insufficiency and precariousness of current technologies to accurately map the biodiversity of the region make it difficult to estimate the value of the information contained in the forest. However, there are already studies that allow measuring and classifying other forms of valuation of biodiversity, including non-use value, associated indirect values and their contribution to the creation of local wealth. This diversity holds a vast set of information relevant to socio-environmental well-being at the present time and, especially, in future scenarios.

The traditional knowledge of indigenous and riverine communities, in turn, has proved effective and consistent in the discovery and use of forest raw materials, such as plant fibers, alkaloids, medicines and other chemical compounds of animal and plant origin. Quinine, for example, is found in the shrub called cinchona and has been used for centuries for its antimalarial properties (*Reis et al., 2019*). Nevertheless, the properties of the scales of the pirarucu fish are being studied in the laboratory for the development of bulletproof vests. These and many other products and derivatives remain a source of discovery for the production of a wide range of sustainable materials, vegetable oils and phytopharmaceuticals from the biodiversity of the Amazon biome (*Lopes et al., 2019*). Nowadays, the innovations of the fine chemistry industry could produce biomolecules with very high added value through biotechnological processes and nanotechnological components.

Historically, ancestral knowledge about biological resources, environment and management practices has been used since the colonization of the Amazon (*Pennano, 1988*). However, the holders of this knowledge have been and are being decimated with the destruction of their cultures and their anthropological relations with the forest (*Alencar et al., 2021*). Currently the Amazon and its inhabitants are threatened by a development model that combines predatory exploitation of natural resources and deep social inequality (*Hecht et al., 2021*). Neoextrativism, disconnected from local reality, promotes the disarticulation of value chains, the destruction of ecosystems and the precariousness of living conditions in the region, especially in the most isolated and remote areas (*McKay, 2017*).

Development visions focusing on sociobiodiversity (*NASEM, 2020*) claim the recognition of

traditional populations and their knowledge in the conservation and sustainable use of resources, for their own benefit and for all humanity. Sociobiodiversity refers to the set of goods and services that result from the connection between biological diversity, sustainable practices and resource management through the cultural knowledge of traditional populations. This is one of the central components of the new bioeconomy, with principles aimed at sustainable development. The products of the forest and aquatic ecosystems are important elements for the constitution of this bioeconomy, especially because they combine social inclusion with the need for forest conservation (*source of raw materials*) and the development of new non-timber products.

The induction of innovation ecosystems respecting regional vocations can promote the emergence of startups that present the potential for production and commercialization at the

molecular scale, such as carotenoids (buriti), anthocyanins and selenium (Brazil nut); quercetins, kaempferol and vitamin C (camu-camu) and caffeine, theobromine, theophylline and catechin (guarana), among other countless bioactive compounds yet to be discovered. These compounds can serve as high added value inputs for the industry (*Willerding et al., 2020*). In this sense, bioprospection of natural resources and new forest products can allow the integration in the Amazon of ST&I centers with the traditional knowledge (*Abramovay et al., 2021*).

The bioeconomy presents itself as a potential vector for the economic development of the Amazon. However, it lacks public or private policy mechanisms that include enabling activities necessary for the construction of a collaborative strategy for the bioprospection of new molecules of biotechnological interest, as well as the elaboration of a research, development and innovation program in bioconversion and fine chemistry. The sectors contemplated in this perspective are opposed to those more traditional or with productivity characteristics more linked to physical capital, since their greatest differential is human capital and the knowledge of the local reality in its particularities, about which new companies and market segments can be created.

The Amazon concentrates more than 10% of known species in just 5% of the total land surface area, and a density of new unparalleled biological materials (*Jetz et al., 2012; Ter Steege et al., 2020*). This diversity goes beyond the number of species, as it is also manifested in ecological functions and chemical compounds (*Asner et al., 2014*). This great potential must be understood as a resource to be protected, but also valued and promoted to boost the improvement in the quality of life of the people who inhabit the Amazon (*Figure 5*).

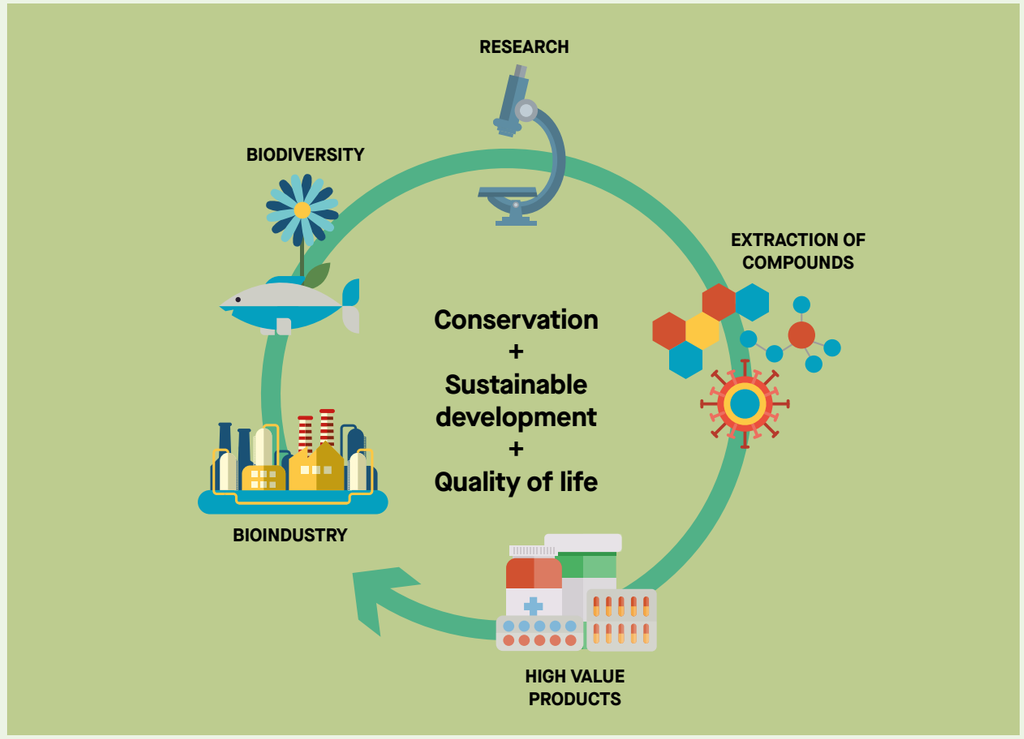


Figure 5. Scheme of the use of biodiversity in the development of bioindustries in the Amazon

Considering these aspects, AmIT has the following objectives:

- **Strengthen and establish value chains considering environmental conservation and strategic segments of the forest economy and water resources.**

The current system places the Amazon at the lowest level of global value chains, as it acts as a provider of agricultural commodities and minerals for international industry inputs. On the other hand, the informal and asymmetric trade relations in the value chains of the main products of the Amazon mainly benefit the segments that act after production, for example, the intermediaries, and not the primary producers. These characteristics reflect the degree of fragmentation of value chains in the Amazon.

The studies and support to reduce the fragmentation of the Amazon region's value chains will provide the tools that will facilitate entry into fair markets and strategic direction to more attractive market segments. This, accompanied by a diversified vision of products and services in accordance with the vocation of each micro-region, will positively impact the conservation of forest and water resources, reducing the pressures in the exploitation of specific resources under high demand.

- **Prospecting forest biomolecules for economic and social development.**

The development of biological technologies for the use of the rich chemical composition of plants, such as acai, guarana, camu-camu, vegetable oils with pharmacological and cosmetic properties, among others, as well as arrangements of multi-institutional, interstate and, if possible, international network projects, can promote the development of research and pro-

duction of molecules of economic interest on an industrial scale.

▪ Contribute to the development of innovative technology and advanced engineering for the improvement of production and logistics infrastructure that is appropriate to the Amazon region

Due to its size, access difficulties, energy deficiency and incipience of communication, the peculiarities of the Amazon region are limiting factors for the development of micro-regions with the use of their natural resources. The challenge is even greater when it is known that a single solution is not feasible for all locations. This depends on the element to be produced, access to the production site and other important aspects so that the site becomes economically effective and can meet market demands. Thus, AmIT should study logistics and infrastructure strategies so that production becomes economically viable and meets the requirements of national and international markets.

In addition to logistics planning, it should contribute to the development of studies and projects of port infrastructure and river transport that prioritize the use of available resources in the region. In parallel, it is necessary to study new energy sources, especially renewable ones, and forms of communication at each stage of the production chain or the modern ways of tracking that guarantee the Amazonian origin of the product (*blockchain technology*). All this in the logic of translational platform for research, development and innovation (*RD&I*) of a project focused on the market and with advanced engineering support.

Strategy Implementation

The relationship of the bioeconomy with technological and market demands is extremely relevant for the success of this work. The bioeconomy is a direct result of the dynamics of the development of products that use biodiversity resources in their composition and can be discovered from the development of different areas of knowledge acting together, including sciences (molecular biology, microbiology, cell biology, genetics, genomics, embryology, immunological, chemical and biochemical techniques, etc.) and technological areas (informatics, the Internet of things, robotics, new materials, process control, etc.).

The starting point of AmIT for the development of the bioeconomy is the elaboration of an agenda anchored in knowledge. For this, it is necessary to strengthen and expand the human resource base and laboratory infrastructure to pursue advanced research lines related mainly to synthetic biology, genomics, proteomics and biomaterials. In the field of training, a massive investment should be made in technical or technological courses focused on the activities of bioindustry (technician in chemistry, technician in pharmacy, biotechnologist, technician in georeferencing, administration and accounting), especially reaching the population with a high level of education in the interior of the Amazon (*Willerding et al., 2020*).

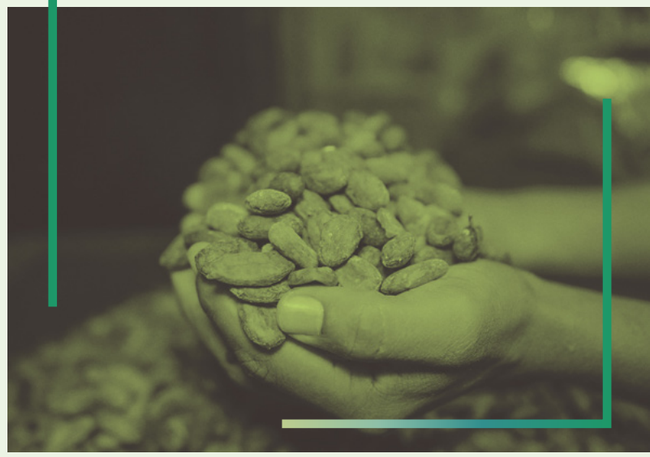
As such, it is necessary to increase the level of knowledge and the development of technologies for the improvement of the basic infrastructure that allows a greater efficiency in generating the activities of the bioeconomy with employment and income in the interior. The use of educational models for the use of local human resources can strengthen these strategic areas, as well as strengthen studies on local and regional problems and challenges.

In order to energize the local economy as quickly as possible, it is necessary to map product value chains with an established market, to identify existing bottlenecks and guide research and development actions to solve specific problems. Thus, the definition of eligible products is based on three main axes as described: the degree of familiarity of the product with the market; the degree of familiarity with technology; and the resources for innovation and production of new knowledge. There are currently several projects with funding to map and evaluate promising value chains.

The creation of a broad bioconversion RD&I program aimed at the cosmetics, toiletries, herbal medicines and herbal medicine industries should be considered together with postgraduate courses in order to promote training in small-scale processing of raw materials from the biodiversity. Two distinct areas can serve as a focus: *a)* biotransformation for small-scale processing of biodiversity raw materials in remote communities or in specialized locations and *b)* biorefineries for large-volume processing of various raw materials on an industrial scale, observing the assumptions of forest and river conservation.

The activities of this component should constitute a translation platform for research, development and innovation (RD&I) with a set of robust technical and managerial processes that bring agility and traceability from basic science, sustainable technology and product development to conquest of an environmentally healthy market. The platform must be agreed upon and adhered to by all stakeholders involved in the triple helix — represented, in summary, by industry, academia and government (*Basecamp, 2017*).

The recognition of places with aptitude and accumulated ethnocognition for the development and commercialization of bioproducts, characterized as production hotspots, can serve as models for the structuring of collaboration networks that connect producers and biopharmaceuticals with regional and international urban centers respecting the principles of fair trade as a key mechanism to improve the quality of life and reduce inequalities.



For an integrated development between knowledge and production, it is necessary to promote the formation of consortiums for collaborative, participatory and enabling research, in addition to the construction of a strategy in networks associated with the interactions between academia and companies. This can be the link to promote the breaking of geographical and political isolation with respect to other regions, imposing the union of efforts through partnerships between local, national and international institutions for the strengthening of scientific research in the Amazon that become research applied to technological development or even intellectual property.

In this context, marketing actions are necessary to reverse this situation and help boost the commercialization of bioproducts, with the possibility of technological densification, transforming them into products with high added value. This vision should allow the use of Amazon biodiversity in niche products with significant market in the coming years due to factors such as the value of the Amazon brand and the appreciation of the origin via the certified origin document (*DOC*). In fact, this may be a relevant

point of action for AmIT, using state-of-the-art biotechnological markers (*ex.: DNA Barcode*).

To contribute to the reduction of social and economic inequalities in the Amazon, it is important to expand and strengthen the development of the region with the use of innovative technologies in products, processes and services that promote the interiorization of the bioeconomy, aiming at the balance in the generation of employment and income for the population of the interior. Thus, it is important that the region is thoroughly known and the greatest natural potential of bioproducts with economic relevance are identified and places of production are created with all scientific technical support.

The task at hand requires time, but it will be the database of a biobusiness ecosystem that is important for long-term strategic planning, and no company, university or government agency can succeed in this venture without connection and integration with social, economic and cultural actors. This is why a clear strategy is needed, involving priority selection, collaboration and focused execution (*Homma, 2012*).

In short, the ambition to constitute a vibrant bioeconomy sector — based on its comparative advantages — will be modulated by knowledge. The establishment of an advanced, pro-science, innovative and production regulatory framework, observing the surrounding conditions, will succeed in boosting a still fragile base of scientists and technologists, entrepreneurs and innovators.

Priority action: Bioeconomy and sustainability

WHAT?

Mapping and consolidation of value chains of importance for environmental conservation, related to strategic segments for forest socioeconomics and water resources.

HOW?

Empowerment of institutions to prospect for new products and processes contained in biodiversity aimed at economic and social development. Creation of collaborative networks/hubs in strategic regions.

WHERE?

Prioritization of hotspots for value chains and environmental conservation in the Amazon, aiming to reduce intraregional inequalities.

Component 3

DISTRIBUTED MANUFACTURING

FOR VALUE CHAINS IN COMMUNITIES

Context

The Amazon and its biodiversity are home to a wide variety of natural resources with the potential to be inserted as products in the markets. In fact, the products of Amazon biodiversity have defined trajectories along value chains. This path goes from the origins of the raw material to the processing prior to final consumption, or even to its reprocessing to obtain products of high added value (*Nobre & Nobre, 2019*).

Throughout the value chain of each product, different actors and locations participate. The Amazonian communities, in the rural context, have a fundamental role in the first stages. These steps generally encompass low-tech processes and include the collection, pre-processing and storage of products. Then, the products are transported to other regions or other countries, where most of the transformation takes place until the final product is obtained (*Nobre & Nobre, 2019*). The participation of Amazonian families and cooperatives in production chains brings economic benefits and new opportunities to improve their quality of life.

The production of vegetable oils derived from Amazonian species is an example that contributes to the diversification of forest products. Around 46,000 households participate in this value chain, which generates US$ 10 million in raw material sales per year (*IBGE, 2019*). However, these value chains face great difficulties. Production volume is limited and of insufficient added value due to poor infrastructure (*Villa Nova, 2020*). In addition, asymmetries between producers and buyers generate dependence on intermediaries, which results in prices below production costs (*Angelo et al., 2018*).

Another prominent sector is fishing and fish farming. Fish technologies have the potential to offer alternatives to the production of other protein sources. In addition, fish represents a source of income in rural areas and food supplies in urban areas (*McGrath et al., 2020*). However, the low levels of technology are evidenced by the difficulty in the flow of production, supply of inputs such as fish feed, scarcity of cold chain technologies and storage and processing facilities. All this is compounded by the lack of organization among fishers and the scarcity of technical assistance (*Jimenez et al., 2020*). These shortcomings force fishers to depreciate their products in negotiations with intermediaries (*INPA, 2018*). At the same time, another area of great potential, very specific to the region and with a dynamic international market, which needs scientific and technological promotion, is that of ornamental fish.

In the previously mentioned cases, the fragmentation and fragility of the structures in the value chains can be evidenced. The conventional structure of these markets is constituted by the unequal distribution of income between extractivists and intermediaries (*De Freitas & Schor, 2020*). Generally, companies acquire products from intermediaries due to low prices, which represents an obstacle for the cooperatives of the Amazon (*CONEXSUS, 2020*). A clear example of this is illustrated by the cumaru (Dipteryx odorata) chain in Pará state, Brazil, for which the price paid per kilogram of the nut was R$3.00 (0.58 USD) for the extractivists, but the profit margin was 75% for the intermediary, 166% for wholesalers in rural areas, and 233% for wholesalers in the state capital (*Silva et al., 2010*).

These characteristics make the products of the Amazon biodiversity uncompetitive when compared to other unsustainable production chains, such as agricultural production (for example, soybeans) and livestock (*Abramovay et al., 2021*). These chains fit into the conventional value chain model, in which high production is prioritized over social, cultural and environmental aspects (*Riisgaard et al., 2010*).

Faced with traditional models of value chains, new technologies emerge. One of the models is distributed production (*Meyerson, 2015*). In traditional production, raw materials are extracted in dispersed zones and subsequently processed in centralized industries. Distributed production, on the other hand, is based on decentralized processes and responds to the growing opportunities of producing small batches of high added value and quality for specific market segments.

Distributed local production offers the possibility of strengthening the participation of Amazonian communities in local areas, but reaching global markets (*Nobre & Nobre, 2019*). The use of modern technologies is one of the pillars of distributed production. This will optimize production processes, prototyping and transport alternatives, for example, by means of cargo drones. The challenge is great and the solutions need to be socialized to attribute value to the products of sociobiodiversity.

Considering these aspects, AmIT has the following objectives:

- **Map products for distributed production, create designs and establish manufacturing strategies and mobility of the parts of the products.**

The forest is the main driving force to boost income generation in the Amazon region and reduce existing social inequalities. At the same time, the forest has the products and is a source for new designs. On the other hand, the forest is an obstacle to the movement of goods, inputs and equipment. The development of technologies adapted to the geographical particularities of the Amazon can promote the modernization of the infrastructure of processing and processing of forest raw materials, increasing the added value of Amazonian products and making the flow of goods and capital more active in the region.

- **Empower educational and research institutions, and local communities to consolidate forest product value chains.**

The value chains of the main Amazon products present weaknesses that are noticeable from the primary processes of extraction and storage of the product to the positioning of the product in the consumer market. Promoting the consolidation of these production chains with scalable businesses, depending on the value of fresh products, is a complex problem.

The value of the products of sociobiodiversity, adding scientific knowledge and advanced technologies to production processes, is a way to structure inclusive, diversified and sustainable value chains. Therefore, quality teaching in research institutions, focused on the use of cutting-edge technologies, will allow us to take the manufacture of products with added value to the interior of the Amazon.

- **Create mechanisms for socialization of technologies and markets connected to the challenges of the Amazon.**

Technological solutions focused on the main issues of the Amazon (problem-oriented solutions) need to be decoded for society and applied to the local realities where value chains are immersed. These mechanisms involve programs that stimulate the transfer of technologies to rural areas and the establishment of digital platforms of technological innovations at the service of the value chains.

However, in addition to specific technological innovations, the ultimate purpose is to create collective awareness in society about the value of the Amazon. First, to know about the utilitarian benefits of the products of sociobiodiversity, and then to create science of intrinsic value of the Amazon and support its conservation.

Implementation strategy

The mapping of the value chains of Amazonian products (*Component 2*) serves as a baseline to identify the fragmented segments in the value chain of a specific product in the priority micro-regions. Recognizing the fragmented segments in the value chain will allow us to identify the problems that need to be solved. In this sense, AmIT proposes the creation of a network of interaction between the main extractivists and/or producers, cooperatives and research institutions. This network will have a multidisciplinary focus aimed at improving the value chain of local productions and developing technological solutions together.

It is also up to AmIT to seek global markets for the establishment of fair trade relations in the process of marketing products from the forest. At the same time, AmIT will and stimulate the use of degraded areas for the development of biobusinesses. Therefore, there is the need to integrate the challenges for the consolidation of the production and market of bioproducts of Amazon origin in domestic and foreign markets, with quality and quantity that meet the demands. In this sense, taking advantage of degraded areas for forest recomposition can be an economic alternative through forest enrichment or fish farming, focusing on medium and long-

-term exploitation.

To contribute to the reduction of social and economic inequalities in the Amazon, it is important to expand and strengthen the development of the region with the use of innovative technologies in products, processes and services that promote the interiorization of the economy, aiming at the balance in the generation of employment and income for the forest population. Consolidating specific and interconnected marketing centers with well-distributed structures, in which the market and producers can have access to raw material more quickly and directly, is necessary. It is also important to establish parameters for fair prices. For the success of this system, it would be necessary to qualify people for the use of technologies associated with infrastructure, accounting, communication, processing, storage, packaging and logistics.

The collection and availability of a database (big data) of information on products of the bioeconomy will be an important tool for producers and entrepreneurs. For this, it is essential to establish data management mechanisms, especially in the case of public access to genetic heritage information.

In addition to information on product characteristics, it is important to provide information on the main actors of the value chains in the database. The agglomerations of companies, enterprises, interactions, cooperation and learning within the same territory can be gathered through value chains.

Thus, producers and entrepreneurs will be able to access financial mechanisms and incentives, such as, for example, access to microcredit. This will allow investment in adding value to products and entering new markets. Finally, the proposed strategies will strengthen the value chains of the products of the Amazon sociobiodiversity.

Priority action: Decentralization of production

WHAT?

Empowerment of local actors with a multidimensional approach (ethnology, economics, designs, engineering, IT, etc.) and creative coalitions for problem-oriented solutions.

HOW?

Mapping the main fragmentations/bottlenecks of value chains and local vocations. Construction of opportunities for economic organization and financing of prioritized and oriented problem solutions.

WHERE?

Prioritization of regions with strong environmental and social pressure to reduce socioeconomic inequalities.

Component 4

TECHNOLOGIES FOR

RECOMPOSITION AND USE OF ALTERED LANDSCAPES

Context

Currently, in the Amazon high rates of deforestation and degradation of its forests are recorded. The original forest cover is decreasing as a consequence of the expansion of the agricultural and urban frontier, the construction of dams and due to mining. Degradation is mainly caused by fires, edge effects produced by deforestation, selective logging, hunting and climate change (*Berenguer et al., 2021*). Approximately 17% (1,036,080 km2) of the Amazon rainforest is degraded (*Mapbiomas, 2020*), which negatively affects the climate, and environmental impacts are perceived across the planet.

Amazonian forests and rivers determine climatic characteristics at the regional, continental and global level. The Amazon is a source of water vapor that supplies the American continent from the equator to the Prata basin (*Pivetta, 2019*). However, deforestation and climate change affect natural climate regulation and can have repercussions on the rainfall regime in places far from the forest. Several studies have already pointed to the fragmentation and savannization of the Amazon, with a longer period of drought, as a consequence of the change in land use, which is caused by extensive livestock farming and agriculture (*Pivetta, 2019*). Therefore, the supply of Amazon ecosystem services is affected at regional and global levels.

In addition, it is estimated that the environmental degradation of the Amazon will result in the increase in global temperature of between 2.5 and 7 ºC. A warming of this order would subject up to 171 million people to water shortages in Central and South America (*IPCC, 2021*). In Brazil alone, rainfall would be reduced by 25%, which could render incompatible and mischaracterize the ecological pattern of the Amazon rainforest (*Pivetta, 2019*). The influence of anthropogenic actions affects the planet and no part of it is safe from the consequences of the increase in the average temperature of the atmosphere and the changes associated with this process (*IPCC, 2021*). The main goal is to limit global warming to an increase of 1.5 ºC. However, it will be difficult to achieve this goal if greenhouse gas emissions are not sharply reduced (*Pivetta, 2021*).

The Amazon plays an important role in the global carbon cycle. However, land use transformation, deforestation and burning contribute to the emission of greenhouse gases. Specifically for methane (*CH4*), the latest surveys between 2010 and 2018 estimated that the Amazon participated with 8% of global emissions of this gas, the second most important after CO2. Although

about 73% of this amount originates from natural processes by decomposition of biomass, the rest was emitted as a byproduct of anthropogenic activities (*Basso et al., 2021*) (*Figure 6*).

Since the 1970s, several government and private initiatives have targeted the occupation of the territory for agriculture and mining and the use of rivers for the generation of hydroelectric power, despite this implying the uncontrolled felling of the forest and disturbance of the Amazon biome. The number of abandoned or altered areas indicates that regional development policies have been ineffective in promoting economic, social and environmental development, as well as the sustainable use of existing biodiversity resources in the region. As a consequence, the production chains of the most commercially exploited species are still fragile, resulting in low productivity, high production costs, low quality products and little or no added value. This scenario potentially results in deforestation of new areas and promotes environmental degradation with negative consequences for the provision of ecosystem services and quality of life of local populations (*Berenguer et al., 2021*).

Given the high resilience capacity of forests with low intensity of use, it is possible to recover the soil and the functionality of the system in up to at least 2.5 decades (*Poorter et al., 2021*). This shows a positive scenario for the development of restoration actions and use of the altered areas (*Barlow et al., 2021*). AmIT will act in an innovative way to take advantage of the changed areas and mitigate the consequences of climate change, in which the Amazon plays a key role of balance.

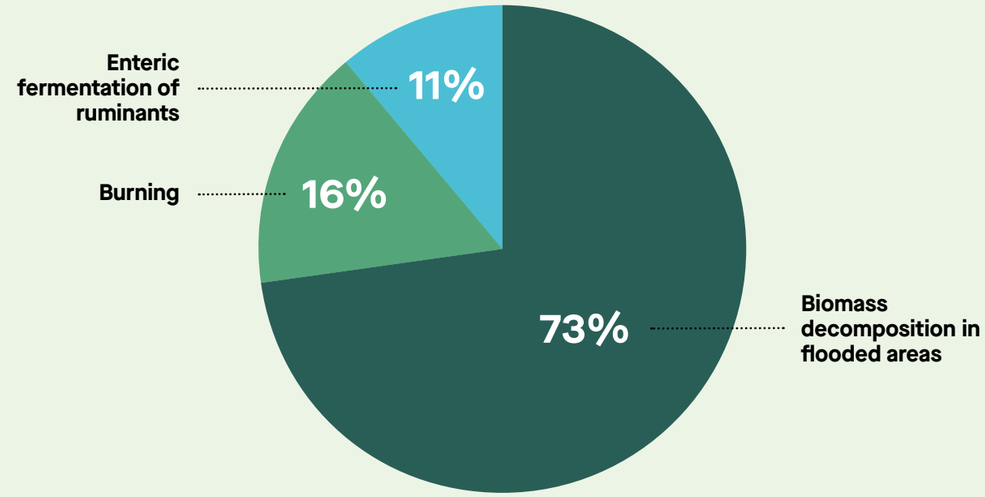


Figure 6. Origin of methane in the Amazon
Source: Image adapted from Pivetta (2022) (FAPESP).

Taking this vision into account, AmIT has the following objectives:

- **Develop technologies for functional rehabilitation of altered environments.**

The advance of the agricultural frontier towards the north of Brazil, the prolongation of days without rain or with very little rainfall during the dry season seems to be one of the events with the potential to disrupt the climate and vegetation of the Amazon. On average, if four months of absolute drought each year occur, you can reach the tipping point. Science has much to contribute to the recovery of altered areas and environmental regeneration through the study of biodiversity, the domestication of commercially relevant native species, the sustainable management of resources such as fisheries, woods and fruits, the provision of infrastructure for its inhabitants, among other alternatives. Science may be the path to solutions to the chronic problems that impede social inclusion, income generation and conservation of the Amazon biome.

- **Expand the offer of technologies for the prevention of environmental degradation and for environmental services.**

The use and exploitation of altered areas provides a great opportunity for the restoration of the environmental, social and economic functions of the forest for society. These areas, with proper planning, can sustain agroforestry and fishing initiatives to ensure the livelihoods of the Amazonian populations. This would also facilitate the recovery of ecosystem functions and services of remaining forests, as production pressures would be focused on areas destined for sustainable productive activities. In addition, the recovery of environmental services in the remaining forests would provide support for the recovery of water quality, soil and the presence of pollinators and dispersers.

- **Use altered and degraded areas for sustainable economic purposes.**

Forest recovery practices cover a wide variety of objectives that range from biodiversity recovery and ecosystem services to improving people's quality of life through resource management activities (*Barlow et al., 2021*). Long-term restoration actions can promote income generation, employment, food security, and become economic assets and an integral part of the value chains of the Amazon bioeconomy.

Implementation strategies

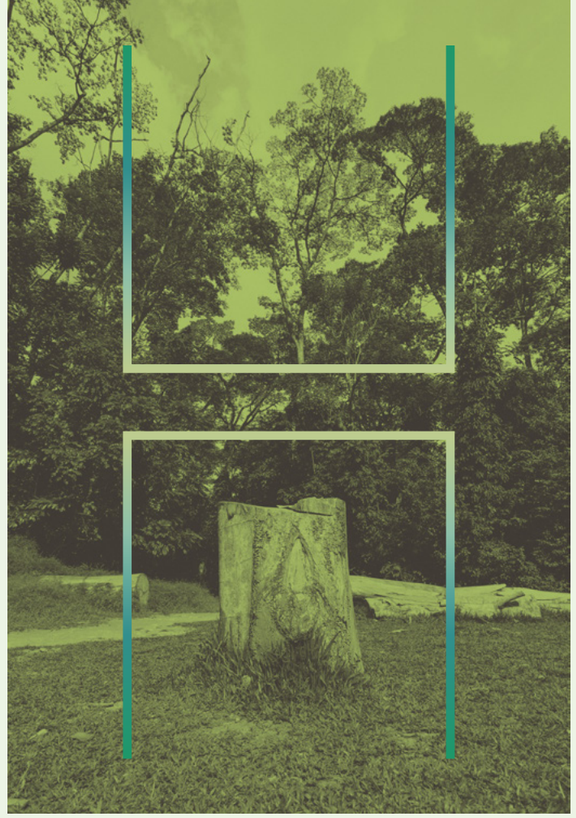
The restructuring of the forest landscape aims to avoid the effects of deforestation in climate change, such as rising temperatures and disruption in the water cycle on a global scale. Complex ecosystems such as the Amazon demand sustainable development models that consider the particularities of the living, preserved and productive forest, in harmony with the peoples who inhabit it. It is essential to promote agroforestry biotechnology aimed at the use and conservation of biodiversity, which is capable of strengthening the strategic segments of fruit growing, fish farming, bioprocessing of forest raw materials, as well as the sustainable exploitation of raw materials that can be used by bioindustries.

Environmental restoration procedures also provide relevant benefits to society, in terms of maintaining, recovering or improving environmental conditions. In this sense, the strategy should contemplate the use of the altered areas, through the sustainable management of non-timber products and fishery resources, transforming them into productive areas in their use and conservation.

The use of altered areas for forest recomposition with economically important species can be one of the alternatives for forest enrichment with a focus on medium and long-term exploitation. For this, it is necessary to establish good national and international relations with various actors of these markets and develop studies and business planning to enable different strategies of collaborative actions, expressively with the participation of the Amazon in this scenario.

Two fields of study are very relevant for the implementation strategy of this component: *a)* the study of technologies and actions that streamline the restitution of ecosystem functions, which prioritize those related to the provision of services in altered areas with moderate disturbance; and *b)* the study of new approaches to the quantification and economic valuation of ecosystem services provided by these forests, such as, for example, through the commercialization of carbon credits or other clean development mechanisms.

It is essential to increase the credibility and representativeness of bioproducts of Amazon origin in domestic and foreign markets, with quality and quantity that meet the demands. For this, it is of great importance to support new markets for forest products and create favorable conditions for the development of biobusinesses, enterprises, research and innovative solutions, with a view to generating competitive products and services with market potential.



Fish farming, for example, is one of the ways to promote the economic restoration of an altered area and an option to promote the development of genetic improvement projects of the main fish species for food consumption and/or the ornamental fish trade.

The local characteristics of soil and climate, combined with cultivation and manufacturing techniques of certain agricultural and food products, result in unique attributes. By indicating that certain products have a specific geographical origin, from which certain qualities, characteristics and reputation derive, an important marketing tool is created, but also for public policies. Forest products, such as acai or Brazil nuts have shown an increase in domestic consumption in Brazil, but also in export indices of several Amazonian countries. With a well-determined geographical reference, the use of altered areas can contribute to the expansion of markets taking into account issues of origin.

Another important area is the development of techniques that enable, in the short term, the production of seedlings of forest species, which have a very slow germination. Thus, potentiating, diffusing and stimulating the development of plant tissue culture techniques can promote a large number of seedlings in the short term (up to 6 months). The culture of animal tissue is also a promising branch, especially for the pharmaceutical industry in the analysis of the actions of phytopharmaceuticals and that can also be within a platform of biotechnology services with market potential in the region. These areas of biotechnology can serve as means for applying knowledge from the possibility of forest recomposition in order to use it intelligently.

The development of a strategic environmental restoration program to monitor climate change, aiming at the adaptation and mitigation of impacts on forest dynamics and human vulnerability, can be a management tool. It can also promote the viability of contributions to the monitoring of climate change and environmental health. The region presents mechanisms that make the Amazon a central element of the global climate. The monitoring actions, of rational use of the living forest, can serve for the restructuring of the environmental services that the Amazon forest presents.

In the first phase of the implementation, it is important to prioritize the mapping and zoning of the altered areas according to the intensity of disturbance. For this, it is important to establish partnerships with institutions that dominate the fields of remote sensing and modeling in the Amazon, such as, for example, the Instituto Nacional de Pesquisas Espaciais (*INPE*), in Brazil.

The lines of activities for the sensing will be based on models processed in computers and environmental monitoring focused on the Amazon rainforest and carried out with the support of satellite images. This approach will serve for continuous work in measuring the dimensions and consequences of the increase in anthropized and degenerated areas. With this, it will be necessary to establish plans for systematization of information on the changed areas that can assist in the creation of strategies that reduce forest fragmentation and promote the use and valuation of these areas of forest recomposition.

The altered areas, with a high degree of disturbance, should be intended for active use for income generation and social inclusion purposes. First, the selection and distribution of the species that make up agroforestry systems must be optimized for productivity and sustainability purposes. Then, indicate spaces in the forest landscape for the development of other activities that prioritize the defragmentation of value chains according to the vocation of each micro-region. This includes energy generation mechanisms, production of supplies and inputs for production chains, generation of appropriate packaging for products, among other activities that support bioeconomy initiatives.

Finally, disturbed areas can provide spaces for forest species banks. It will also be important to invest in the creation of a seed bank of Amazonian plant species, especially those that make up the group of wild relatives of domesticated plants. Thus, in the imminent future of climate change, the valuable genetic information of these plants can provide solutions for food security.

Priority action: Economic and ecological use of altered areas

WHAT?

Development of technologies for the use of altered areas for environmental and economic purposes.

HOW?

Promotion of forest enrichment based on technical and scientific information available to the Amazon. Socio-economic and environmental modeling for the use of altered areas.

WHERE?

Places that allow the use of agroecological techniques according to local vocations prioritizing the reduction of environmental pressure and socioeconomic inequalities.

Component 5

EDUCATIONAL MODELS

Context

The education scenario in the Amazon is both challenging and worrying. It is challenging because the communities of the interior of the Amazon do not receive information and knowledge to take advantage of the economic and social potential existing in their localities. Infrastructure and incipient communication are obstacles to access to education (*Alencar et al., 2021*). Consequently, it is worrying because it limits social inclusion and accelerates internal migration processes to large urban centers.

Access to quality education is a human right and a means to achieve social justice (Hohenthal & Minoia, 2021). Access to education, understood in its broadest sense, encompasses ecological, cultural and linguistic diversity in all its stages (*Nakata et al., 2012*) and not just going to school. Education in the Amazon necessarily permeates the dimensions of the diversity of cultural identities of indigenous and traditional peoples, quilombolas, ribeirinhos and caboclos, and the lack of intercultural perspective is a structural problem.

In general, education does not recognize the knowledge, practices and natural resources that already exist in the Amazon region. Knowledge of indigenous communities and riverine populations has been systematically ignored (*Frieri et al., 2021*), through the imposition and development of educational models with curricula designed under exogenous hegemonic models (Varese et al., 2021). In the opposite sense, participatory and locally appropriate educational curricula are a path to inclusive education in the region (*Alencar et al., 2021*).

In the Brazilian Amazon, the schooling rate (ratio between the total number of enrolments and the corresponding population in the expected age group) in high school corresponds to 72%. At this stage, 31% of students are older than expected for the year in which they are enrolled. The same happens in higher education, which has a 31.7% schooling rate. The educational journey of Amazonian youth is strongly affected by the obstacles linked to the low capillarity of educational networks in rural areas and the low dynamism of the labor market (*Cruz & Portella, 2021*).

On the other hand, the ST&I system in the Amazon is heterogeneous, which reflects the inequality in the availability of technical and institutional resources. The scarcity of qualified professionals and the discontinuity of financial resources are signs that science is not yet treated as a means of social and economic development in the Amazon (*De Assisi, 2012;* CGEE, *2013*). When analyzing the educational formation in the

region, there are no models directed to technological processes that can be useful for the demands of society in relation to local problems. Little is converted into research that is applied to technological development or even intellectual property.

The creation of new teaching modalities and innovative approaches regarding biodiversity with the strengthening of entrepreneurship (*UEA, 2020*), as well as the creation of transdisciplinary centers and educational centers of excellence, demand large-scale public-private financial incentives. A good example of these new approaches, which has enabled institutional and professional exchanges, is the Escola de Negócios Sociais da Floresta, located in the state of Amazonas (*Brazil*), co-created by the Universidade do Estado do Amazonas and the Instituto de Estudos Avançados at the Universidade de São Paulo (*Abramovay et al., 2021*).

The development of the bioeconomy depends on new technologies based on local knowledge (*De Assis et al., 2021*). For this reason, the principles of sociodiversity in the Amazon are fundamental to begin the transition to a sustainable economy (*Abramovay et al., 2021*). At the same time, education must stay connected with the global ST&I ecosystem and ensure cognition processes for Amazonian students. These educational models can provide local talent with the skills to meet the demands of each micro-region and international markets (*De Assis et al., 2021*).

Considering the previously mentioned aspects, AmIT has the following objectives:

- **Involve high school, technical and technological institutions as a network in the training of young people for the Pan-Amazon of the 21st century.**

In a territory of continental dimensions and of difficult mobility, the formation of networks allows a better use of the already installed infrastructure and collaborative interaction. In this way, it creates dynamic flows of knowledge, generates prospects for social inclusion and reduces asymmetry in information transfer. The culture of sharing, accelerated by digital means, is a means to strengthen relationships of trust and solidarity, which optimizes the technical and human resources existing in the region, from which creative solutions can emerge.

- **Contribute to the design and implementation of training models appropriate to the Amazon environment.**

It is important that the pedagogical processes are open to social participation, to establish a coherence between the student or researcher and the Amazonian environment. Educational models developed by indigenous and traditional peoples over generations have been completely nullified and lost by formal education. Education conceived from a collective and Amazonian perspective needs elements that blend and contemplate regional realities to establish identity relationships that arouse engagement, recognition, interest and motivation.

- **Strengthen and expand capacity building and extension programs for the sustainable development and conservation of the Pan-Amazon.**

Extension programs have great potential to strengthen an economy based on knowledge of nature. In addition, they allow educational and research institutions to adapt to increasingly volatile social changes, promoting the decoding of scientific knowledge in favor of social inclusion and socio-environmental development. It is worth mentioning here the guidelines for extension in Brazilian higher education, which regulates the provisions of Law No. 13,005/2014, which defines execution as an ethical reflection on the social dimension of teaching and research, through the dialogical interaction of the academic community with society and the exchange of knowledge, participation and contact with contemporary complex issues present in the social context.

- **Facilitate the mobility and exchange of researchers and students participating in activities related to the sustainable development of the Amazon.**

The mobility of people and information is generally a factor of dynamization of the economy, since in addition to favoring technological transfer and Interculturality, they demand a range of associated services such as transportation, lodging, gastronomy, tourism and events. However, Amazonian cultural diversity is disconnected from globalization processes, in addition to being fragmented and bringing negative consequences for education and sustainability. Even so, there are viable alternatives such as crowdsourcing systems used widely around the world to solve a variety of complex problems in a shared face-to-face, virtual or hybrid way, with non-monetary motivations ranging from the fun and pleasure that experiences provide taxpayers to the identification of the community with the proposed challenges.

Implementation strategies

AmIT proposes the formulation of regional strategies to contribute to the acceleration of educational transformations that the Amazon needs to achieve sustainable development. In addition, AmIT also proposes the creation of paradidactic programs and supplementary education materials, with content that incorporates environmental characteristics, such as endemic biodiversity and ethnocognition. In this way, it will recognize the fundamental contributions of the Amazonian peoples in regional and global development.

The strengthening of identity through the awareness of people about the Amazon culture has a fundamental role, and should involve the most basic levels of education that constitute the pillars for a new vision of the Amazon. This change involves reforms in basic education and the training of highly qualified staff in ST&I with a focus on sustainable economic activities based on the use of Amazon biodiversity. Thus, it is also important to include the knowledge of the natural resources present in each micro-region with the notion of entrepreneurship from the first years of education.

Changes in educational processes need actions in the field of public policies, in order to allow them to be strongly influenced by local dynamics and contexts, adapting to geographical limitations and connecting with research institutions, private initiatives and public managers to quickly drive the necessary improvements in the educational system. AmIT will work in articulating and convincing local and regional stakeholders about the importance of investment in ST&I as the engine of development and social inclusion in the Amazon, providing data and evidence for decision making.

There is a need for long-term strategic planning for capacity building and extension programs for sustainable development and environmental conservation. The relationships between science, technology, innovation and development are interactive, simultaneous and complex, with people as the main driving force of a virtuous cycle. From this perspective, the central argument is that the performance or degree of success of this training depends fundamentally on two conditions: a) capacity to allocate financial resources for this to become a reality; and b) an environment with common objectives and languages that allow sharing information and knowledge applicable to the local reality for the solutions of economic, environmental and social demands.

It is also necessary to expand and strengthen training programs for selected locations (hotspots) that consider local vocations to promote the equitable improvement of scientific and technological knowledge in the micro-regions of the interior, and reduce asymmetries with the most developed regions of each Amazonian country. One strategy is the rapprochement between qualified researchers to facilitate the transfer of knowledge and technology in order to promote an immersive experience of these professionals with the local society (1-2 years, for example) and induce a positive interaction that stimulates the fixation of people in the Amazon.

Another line of action is to stimulate and strengthen low-complexity enterprises for the solutions of problems and increase the technological density of each innovation ecosystem of Pan-Amazon. Supporting the training of technical and higher level personnel in strategic areas is key. It is necessary to foster or articulate initiatives for the existence of scholarships for technical courses of medium level. In addition, the contribution via higher technology courses according to localized demands is a medium and long-term strategic action for AmIT.

For this, AmIT should promote partnerships with technical-technological education institutions for the development of collaborative educational models and enablers necessary for the understanding and solution of the problems of the Amazon reality. These coalitions of creative networks should provoke systematic and continuous interactions between academia, society and companies for the development of solutions oriented to local problems, as well as promote the breaking of the geographical isolation of the region with the exchange of students and professors. This requires the uniting of efforts through partnerships between state, federal and international institutions to strengthen the education and training of very high level personnel in the Amazon.

The AmIT proposal initially involves supporting graduate programs related to the areas of knowledge needed to achieve the development goals in the region. Figure 7 shows the fundamental areas of knowledge with specialties that can potentially be developed in partnership with Amazonian institutions and international institutes such as MIT.

ADVANCED TECHNOLOGIES FOR THE AMAZON	**Technologies Engineering**	Robotics Nanotechnology Data Science Telecommunication Smartforest(Iot) Computer Science
HUMAN DEVELOPMENT FOR AMAZONIA	**Education Economy**	Biomimetic Design Architecture and Urbanism International Relations Intercultural Education Bioeconomy
SUSTAINABLE OF THE AMAZON BIOME	**Agroecology Engineering**	Metereology Cosmetology Green Finance Blockchain
AMAZON ENVIROMENTAL SERVICES	**Ecology Climatology**	Agroecology Engineering Climatology Biotechnology
APPLIED BIOLOGICAL SCIENCES FOR THE DEVELOPMENT OF THE AMAZON	**Biotechnology Genetics**	Biochemistry Pharmaceutical Sciences Tropical Medicine Microbiology and Immunology Veterinary Medicine

Figure 7. Fundamental areas of knowledge and specializations.

Priority action:
Innovative ideas for Amazonian solutions

WHAT?

Management and execution of education processes appropriate to the Amazonian realities with the use of traditional and innovative knowledge to increase the technological density for the generation of products, services and processes with differentiated quality and competitiveness.

HOW?

Incorporation of cultural, environmental and socioeconomic characteristics in the design of pedagogical processes and critical data analysis (data literacy) in the Amazon. Stimulation of mobility and staffing in the interior of the Amazon for interaction with local talents and development of creative solutions.

WHERE?

Micro-regions along the Amazon River where there is consolidated demand for development actions and personnel instrumentalization for the improvement of local socioeconomic conditions.

Component 6

RECRUITMENT OF PERSONNEL

Context

The lack of qualified personnel has consequences that restrict the possibilities of development in the Amazon. The dropout of excellent researchers, the search for complementary sources of income unrelated to scientific research and the abandonment of people with an academic profile for careers linked to ST&I contribute to this lack (*Tourinho et al., 2021*). This reality perpetuates the role of foreign researchers and hinders the appropriation of information about the Amazon produced in other countries (*Val & De Almeida, 2005*).

The scarce number of employment opportunities in the interior of the Amazon region cause the migration of young people to urban areas with the hope of improving their quality of life. In the Amazon region, cities expand, the population increases, but the quality of life does not improve for most of its inhabitants (*PAS, 2008*).

The use of natural resources as support for a forest-based economy, the complexity and diversity existing in the region require high-level financial and personnel resources, which does not exist in the dimensions necessary for the development of the region. Even considering the region's low population, the number of scientists per capita in the Pan-Amazon is far from rates that can be considered reasonable. This situation has persisted over time and has determined the delay of sustainable development in all Amazonian countries.

The recruitment of qualified personnel is one of the central factors since production chains are not structured to provide technical-scientific support for the use of biodiversity with environmental conservation. This activity, today, is restricted to family extractivism, with inefficient management processes and products with low quality and uniformity, with little or no added value. These factors impede the competitiveness of the product and reduce the benefit to the agents involved, particularly due to the lack of qualified personnel with a multidisciplinary vision. Perhaps, this is the key point for the consolidation of value chains, i.e., the existence of agents capable of appropriating technical-scientific information that allows the sustainability of value chains. In other words, the training of those who can live on the inputs existing in the natural environment as a way to increase the quality and efficiency of production processes, with added value. Training is essential from the primary level of initial collection and processing to the most elaborate stages.

The basis of the historical recruitment of qualified personnel is due to the economic im-

portance of forest extractivism, which has presented modifications throughout history with various products that had great importance in the economic, social and political formation throughout the socio-economic history of the Amazon. The "drugs of the hinterland" in the colonial era stand out; cocoa (*Theobroma cacao*), rubber (*Hevea brasiliensis*), Brazil nut (*Bertholletia excelsa*), palm hearts and acai fruit (*Euterpe oleraceae*), which persist to this day, added to the recent intensive extraction of timber without management (*Homma, 2014*). Therefore, it is necessary to resume the recruitment of excellent personnel for the new scenarios that are presented in the Pan-Amazon.

With a new perspective for the recruitment of qualified personnel to strengthen value chains, these forest-based economic activities can represent an opportunity for scientific and technological development based on the socio-ecological characteristics of each micro-region (*Val, 2006*). As a consequence, the region can move from a source of fresh resources and raw materials to some strengthened value chains that exceed the basic level of their processing.

There is a critical need to establish technical personnel to act as qualified professionals for the bioIndustry in the Amazon (*Willerding et al., 2020*). Although, it is possible to identify several mid-level institutions in several inland regions in the countries of the basin (*Willerding et al., 2020*), the recruitment and establishment of qualified personnel is affected by the prevalence of unemployment, informal employment and very poor or non-existent vocational training (*Painter et al., 2021*).

With this, the training of young people can contribute to transforming them into agents and promote a basic economy that is intrinsically linked to the interior of the Amazon. This process can positively influence the bioeconomy and contribute to the development of cities and communities in the region. At the same time, at undergraduate and postgraduate levels, the strengthening of "poles of knowledge" in strategic regions of the Amazon would allow the establishment of qualified personnel who would serve precisely for the training of young people regarding their professionalization in the Amazon bioeconomy.

Currently, Amazonian graduate programs, specifically from the Brazilian Amazon, contribute to the training of researchers who will potentially work in local institutions. Unfortunately, there is a drastic reduction in investments in scholarships and research, which affects the ability to create conditions for the development of qualified local personnel, further reducing the training and fixation of researchers to work in the Amazon region (*Tourinho et al., 2021*).

To meet the current challenge in the Amazon, it is essential to expand ST&I capabilities in the region. One of the ways to boost sustainable development is to increase productivity with a well-trained workforce (*UNESCO, 2015*). The success of the establishment of qualified personnel will depend on the involvement of different sectors of society, with mechanisms that start with the implementation of scholarships for various levels to public entrance exams for definitive hiring (*Val, 2006*).

To promote the fixation of outstanding personnel in the Amazon, it is vital to maintain a cross-sectional view of all the components considered by AmIT, more specifically, the components of "educational models" and "business and economics supported by ST&I". In this light, the following objectives were listed:

- **Promote mechanisms to stimulate the establishment of qualified personnel for scientific and technological production in the Pan-Amazon, with emphasis on strategic sectors in line with AmIT's mission.**

The sophisticated technical basis of modern biotechnology enables the creation of a huge range of new products and processes. This means that the Amazon has a window of opportunity for professionals with technical and scientific qualifications to participate in a significant way in this challenge, which guarantees the competitive space for innovative products and processes of biological basis, in vital segments such as agriculture, health and the chemical, materials and energy industries.

- **Promote regional, national and international cooperation, enabling the creation of thematic networks, minimize efforts and stimulate integrated scientific initiatives for the study of the environments and biodiversity of the Amazon.**

In the Amazon, the accelerated processes of deforestation make integrated national, regional and international actions that promote viable economic alternatives for the region an urgent requirement. For this, a scientific and technological agenda that promotes socio-environmental development is important for solutions to current problems and demands, and which generates social inclusion and opportunities for future generations.

Implementation strategies

The establishment of highly qualified personnel in the Amazon is fundamental, in other words, the region needs to be attractive from a scientific and technological point of view, both for personnel from the region and from outside. To be attractive, the region must have infrastructure equipped with modern sustainable technologies that provide comfortable environments, laboratories and facilities for researchers involved in AmIT projects.

In the Amazon region, there is a need to train qualified personnel for the development of technologies, for the production of inputs and for the development of products with added value to international quality standards. The starting point of the AmIT agenda is to recognize that the development of innovative solutions in the field of biosciences must be anchored in the knowledge originating from those who know and/or live in the forest.

The attraction of senior researchers, on the other hand, aims to strengthen and create research groups in priority areas for socio-environmental development. These groups should count on, whenever possible, the participation of Amazonian students from the classes of the undergraduate and graduate programs offered by AmIT. To generate a critical mass of qualified

researchers and scientific-technological leaders it is necessary to create or reinforce, on a competitive basis, a narrower set of highly qualified research groups, facilitating their articulation with international institutions of high renown, so that these groups also become a reference at the frontier of knowledge.

Therefore, it is necessary to strengthen and expand the human resource base and laboratory infrastructure to develop advanced research lines related mainly for synthetic biology, genomics, proteomics and biomaterial engineering, which can, above all, offer solutions to problems and make possible the desired socio-economic development. For this, it is important that the raising of financial resources is public-private, as previously mentioned, through partnerships with large companies and national and international industries.

In addition, it is necessary to support the establishment of very high-level staff through supranational mechanisms that are attractive and advantageous, which guarantee fair rights and remuneration, observing the standards of the OECD countries. Promoting a culture of technological innovation is key to attracting biobusinesses and talent to the Amazon. The strategy also involves monitoring the dynamics of the economic and productive system of each micro-region to anticipate the demands of the labor market and provide specific and intensive training in each case.

Floating and itinerant campuses are a new concept proposed here by AmIT to meet the accommodation needs for researchers and technical personnel, in addition to facilitating mobility to the different Amazonian micro-regions, integrating and activating local knowledge chains through courses, projects, workshops, seminars and workshops. These structures will transform the Amazon River into an artery of knowledge, and can be displaced when necessary. For the private initiative of the Amazonian countries and other countries, which, perhaps, have some participation in Amazon value chains, the structures could serve as a basis for cooperation in projects involving staff training. Finally, the official initiatives of each country could serve as auxiliary agents to promote activities that can support, above all, the areas of education and health.

Scientific and technological management models for social and economic development, through technology and knowledge transfer, should be used. At the same time, the models should stimulate the regional mobility of personnel as a way to bring their realities closer to the technological potential for improving the quality of life and increasing income, with the efficient use of the natural assets of the Amazon. The socialization of scientific knowledge in favor of the community/society should be the driving force and the use of information technology (IT) should be the main vector for these actions.

Priority action: Expansion of technical and scientific capacity in the Amazon

WHAT?

Attraction, training and staffing to produce information and develop sustainable technologies and businesses for social inclusion and income generation in the Amazon.

HOW?

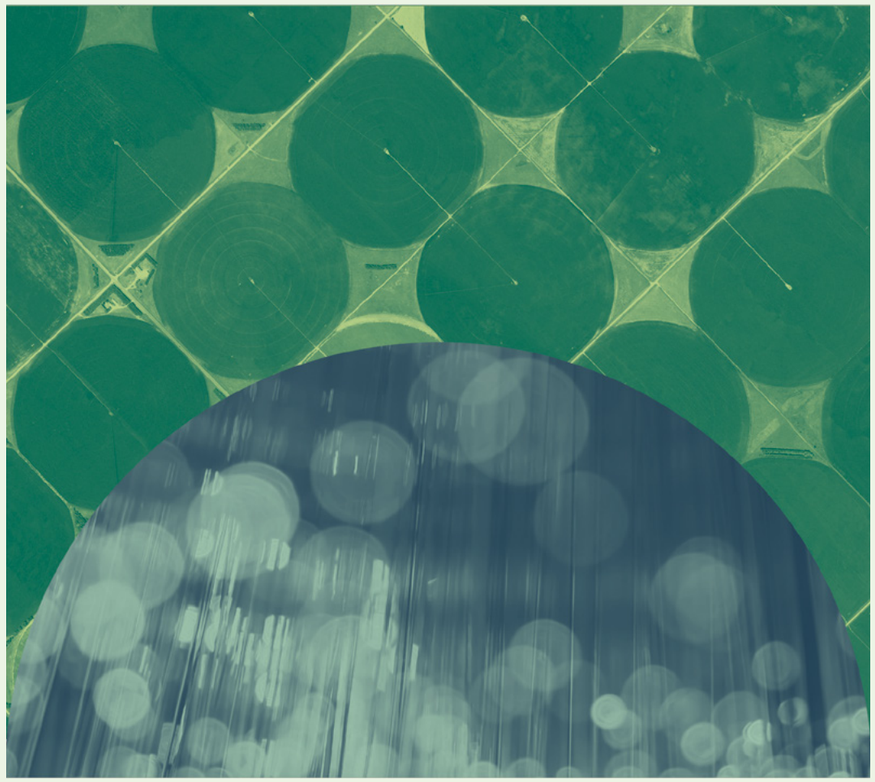
Development of an international fundraising mechanism to support existing institutions, new facilities and new information production initiatives for social inclusion and income generation.

WHERE?

Establishment of strategic areas for knowledge production and dissemination of information in the different micro-regions of the Amazon biome, decentralized from the most developed regional urban centers.

Component 7

OUTREACH



Context

In the Amazon, the challenge is to align technologies with the valorization of regional singularities and the identification of the ways of using natural resources already used by the Amazonian peoples. Training needs make universities and institutes that develop technologies active participants who must be involved in the processes of socialization of information. The social and economic segments, promoters of the value and knowledge chains, must unite in the appropriation of information.

The meeting between science and society for the purpose of appropriation and use of technology happens through extension, which should be a dialogical and transdisciplinary activity in order to contribute to society. It is necessary to improve the socialization of information through material or intangible technological products, as a tool for a productive process that results in social inclusion and income generation. In this direction, social technology provides the guidelines for designing technological extension projects in line with the local social scenario (*Addor, 2020*).

The socialization of information involves the democratization of the technological process with the inclusion of different actors in the exchange of knowledge and decision-making, especially the numerous small sectors of the popular economy and the most vulnerable sectors of the population (*Addor, 2020*). In recent decades, initiatives have been identified for the development of technologies that have provided the social inclusion of Amazonian communities in food production projects, food and nutritional security, education and the environment, sustainable materials and health prevention, and recovery of areas degraded by mining, which could serve as demonstration units.

Society, in general, has a positive image of research in science and technology, but there is skepticism about its benefits and little confidence in its effectiveness as an instrument for the solution of problems (*Delabio et al., 2021*). This is a constantly evolving scenario. There is still a lack of a symbiosis of science and society that promotes an intense movement of information beyond the academia.

For this horizon, open science, a movement within and outside academia that has been gaining ground, proposes to make science collaborative, shared and public. This will be achieved through the sharing of methodologies, data, metadata, software, reports and information on the production of a particular good or service, markets, and an endless number of possibilities in favor of the use of science and technology in

income generation and social inclusion in the Amazon.

In this scenario, AmIT has the following objectives:

▪ Promote the decoding of scientific information for its socialization in the Amazon.

In the Amazon region, science, besides being little valued, is often pointed out as a supposed "limiting factor" for "industrial urban progress". This vision needs to be overcome through the strengthening of interaction with society for the legitimization of the work of the scientific-technological community, from the social impact to the appropriation by the local society in the distribution and use of knowledge for the common well-being.

▪ Promote dialogue between academia and the various social and economic segments of the Amazon to strengthen the value chains of forest products.

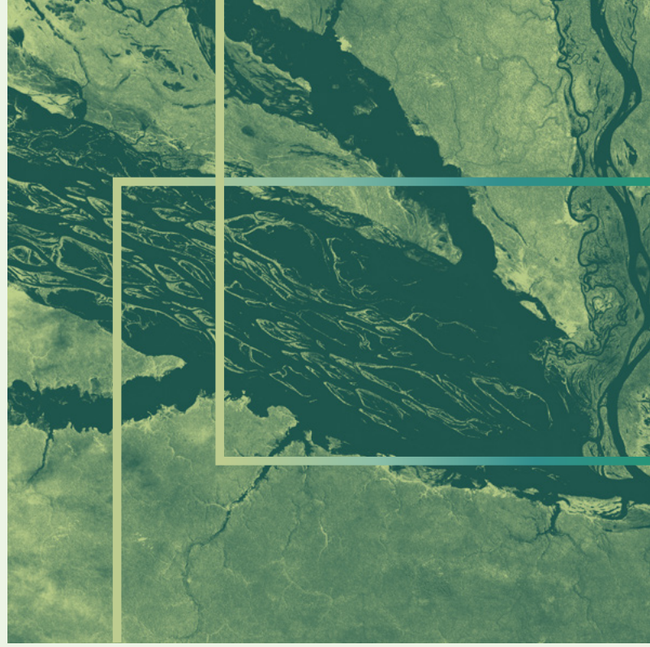
The paradigm proposed by AmIT's mission is to transform scientific knowledge into business opportunities in the Amazon, especially in the interior, where biobusiness opportunities are concentrated. Stimulating investment and training of small producers, micro-entrepreneurs and bio-industries, with support from ST&I institutions diversifies value chains and flows scientific knowledge to society through business.

▪ Contribute to the implementation of a data and metadata integration platform regarding Amazon ecosystems and their biodiversity.

This is an effort with demands from all sectors of the economy, which will strengthen education, health, safety and other services. Infohighways need to be modernized to expand digital inclusion throughout the Amazon, especially in the interior. The benefits generated by digital inclusion, in the medium and long term, will impact various social areas and economic development. Examples are: a) feasibility of telehealth, distance learning and security; b) modernization and creation of telecenters; c) reduction of telecommunication costs allowing the use of convergent technologies (data, voice and video over IP); d) greater interconnection of direct and indirect administration bodies; and e) business generation.

▪ Create an ecosystem of artificial intelligence for problem solving and monitoring Amazonian challenges.

Advances in the areas of data science and engineering, in line with advances in computers with high processing power and cloud computing, allow the development of efficient predictive models, and future scenarios regarding climate change, as well as economic panoramas and behavioral patterns. The combination of these advanced analytical technologies could be decisive for the future of the Amazon and for humanity.



Implementation strategies

The importance of including scientific knowledge and technological innovation as part of strategies to raise awareness of the needs for sustainable development in the Amazon has been constantly addressed in the thematic components of the AmIT project in order to generate income, improve the quality of life and the conservation of the environment.

In this direction, it is essential to establish mechanisms for dialogue between academia, companies and small producers through workshops, development of field activities and programs that involve students of technological institutes in solving specific problems of the value chains of each micro-region. It is important to consolidate a microclimatic, health, biodiversity database. For this, it is necessary to create digital platforms in which citizens can participate by entering data collected by themselves following pre-established protocols.

An open access platform with information about the Amazon and its diversity, natural resources and their current and potential uses for industries and commerce will via the use of artificial intelligence, serve as a source for modeling costs, potential markets, consumer trends, future scenarios, and microclimatic modeling, among other innovations.

The use of platforms capable of integrating interinstitutional technological infrastructures, producers and market demands will enable direct interaction between the various actors. This initiative will require funds/financing for the consolidation of a database (big data). It will also require the training of qualified data science personnel specialized in the strategic areas of the bioeconomy.

It is also important to stimulate the interest and development of a scientific culture in society, through non-strictly academic channels with the awareness of the importance and the diffusion in ST&I with priority for the regions most dependent on the forest. Among the main activities is to stimulate and guide scientific dissemination in its various modalities, through the use of dissemination magazines, audiovisual media, cartoons, creation of virtual games, collections and mini-scientific museums with a transdisci-

plinary vision. Another strategic line should be to organize, promote and sponsor competitions (challenges) to involve the community in solving the various local problems.

Supporting the creation, consolidation and expansion of innovation environments is fundamental for the development of artificial intelligence in several areas of knowledge in the Amazon as a way to seek problem solving. The strengthening of technology-based businesses, with potential for the creation of new companies and startups, will take place through cooperation with other institutions. The transfer of technologies in strategic sectors will also be stimulated through this cooperation. For this, the implementation and maintenance of innovation environments (incubators, accelerators, technology parks, vocational centers for sustainable development, etc.), which consider local vocations and potential, and the sustainable use of biodiversity and natural resources. In other words, it is necessary to invest and promote the modernization, expansion and maintenance of the infrastructure of decoding science for society.

Priority action: Amazonian empowerment

WHAT?

Decoding and systematic transfer of scientific information about the Amazon to the local society, aiming at the conservation and sustainable development of the region.

HOW?

By structuring a dynamic and open data and metadata platform based on information about the Amazon existing in different national and international institutions (data science solutions) and socialization of creative solutions aimed at the challenges of the Amazon ecosystem.

WHERE?

Decentralization and migration of science and technology produced in large urban centers to the interior of the Amazon.

Component 8

BUSINESS AND ECONOMY

SUPPORTED BY ST&I

Context

A sustainable, dynamic and modern economy in the Pan-Amazon begins with the discovery and transformation of information contained in the environment, which is capable of converting natural resources into environmental assets. In the Amazon, there are many sociobiodiversity products used for traditional and innovative purposes in the industries of cosmetics, food, and drugs, among others, at different levels of processing (*Abramovay et al., 2021*). More than 200 plant species have proven their potential to sustain initiatives in the low-cost bioeconomy (*Nobre & Nobre, 2019*). In other words, the Amazon biome offers unique conditions to boost new businesses based on innovation, conservation and sustainability.

According to the Brazilian National Bank for Economic and Social Development (*BNDES*), the value of businesses related to the Brazilian bioeconomy amounted to US$ 285.9 billion in 2018. This figure corresponded to 13.8% of the country's GDP this year, a percentage similar to 14.3%, which was the contribution to the GDP of the bioeconomy in the European Union in 2013. These numbers do not mean that Brazil makes good use of its bioeconomic potential, since it incorporates the production and export of agricultural commodities (*Viana, 2021*). An advanced bioeconomy is still incipient in Brazil, especially in the Amazon region. The study shows that the current content of the bioeconomy in industry and services reached a mere US$ 101.4 billion in 2018, corresponding to 2.6% of the value of production and represents the lowest level of the Brazilian bioeconomy (*Viana, 2021*).

The best known examples of the bioeconomy in Brazil are those of large companies that exploit biodiversity to produce consumer goods, fuels and biodegradable materials. This is the case in the sectors of personal hygiene, perfumery and cosmetics, which represent the highest demands for raw materials in the region. With a total market in Brazil estimated at US$ 25 billion in 2020, the amount corresponding to sociobiodiversity products has been growing. Natural ingredients have been used in packagings with Amazonian visual appeal and industries are replacing synthetic inputs with natural ones, in a process called "vegetalization of ingredients". The prospect is that the global natural cosmetics market will reach US$ 48 billion by 2025 (*Viana, 2021*).

A major obstacle to the full development of the bioeconomy is the still sparse and fragmented character of these initiatives. The form of raw material conversion is primary and there is an urgent need for technological develop-

ment and professional qualification in the value chains. The purely extractive model adopted for products that present conflict between supply and demand, as occurs with the rubber tree, Brazil nuts, acai, tucumã, rosewood, mahogany, paricá (*Schizolobium amazonicum*), cumaru (*Dipteryx odorata*), among others, demonstrates the misconception of the belief in the availability of extractive resources as a barrier to stimulate plantations and promote standardization in the supply of raw materials. As such, the expansion of the supply of raw materials with managed plantations requires technical qualification and professionalization to maintain competitiveness. Adding acai berries and products such as

babassu, Brazil nut and cumaru, the northern region stands out in non-timber forest production with 45% of national production, totaling more than US$ 147 million per year. Second, the southern region has 29% of the extractive production, or US$ 94 million annually. In total, non-timber extractivism is worth US$ 338 million annually in Brazil, according to data from the Brazilian Institute of Geography and Statistics (IBGE) (*Viana, 2021*).

The transfer of resources from the Amazon biodiversity and the belief in its inexhaustibility have seriously hampered regional development. The domestication of crops and non-timber forest management are paradigms to be broken in the way of how to exploit the forest. It is necessary to take into account in this context the importance of working with the living forest and its active environmental functionalities. As a rule, the success of domestication tends to happen outside the areas of occurrence of the extractive resource (*Homma, 2014*). The product that stands out the most as a successful example of extractivism and forest management is the acai berry. In the Amazon, the market for this palm fruit is worth US$ 634 million a year, with a local economic impact of US$ 60 million in extraction and domesticated cultivation, according to the latest social balance published by the Empresa Brasileira de Pesquisa Agropecuária (*EMBRAPA*), in 2019. Therefore, in the micro-regions of production, the aggregation of value, from scientific and technological information is necessary in order to optimize the processes of social inclusion and income generation.

The existing bioIndustry in the Amazon is emerging and uses a technological level of low to medium complexity. It adopts classical biotechnology and uses natural resources subjected to simple processing processes. Bioindustries can also use biodiversity in natura or simple processes such as cutting and drying, extraction and distillation to obtain fixed and essential oils. There is little or no occurrence of biobusinesses that include chemical or biological processes of high complexity, involving technical risks and the mandatory testing (standardization) applicable in perfumery, cosmetics, bioenergy and herbal activities (*Silva & Mafra, 2017*). For example, for herbal products such as copaiba oil (*Copaifera spp.*) homemade syrups can be found at fairs and markets or even capsules from local companies. For drinks, in general, guaraná (Paullinia cupana) can be obtained as a powder in markets. For the local cosmetics or hygiene and cleaning industries, the production of products is restricted to lotions, creams and capsules (*Queiroz & Mafra, 2017*).

In the forest context, so-called biorefineries could take advantage of all parts of agricultural and extractive inputs (bark, pulp, bagasse, straw, seeds) to generate food, biofuels and other biomaterials. In addition, it could extract a huge diversity of products from raw materials, from biofuels to active ingredients of medicines. The second generation biorefineries are centers where several companies operate in a coordinated way, with the waste of some serving as raw material for others and the chains are integrated in industrial symbiosis.

On the other hand, current challenges in economic, environmental and social issues lead to a dilemma: *(a)* continue growing at relatively low rates with a high cost to the environment and a deep social depression, or *(b)* change this pattern of development and seek sustained and inclusive economic growth to ensure the provision of environmental goods and services on which the development of a country and the well-being of its society depend.

The green economy offers an opportunity to promote integral development, incorporating its economic, social and environmental dimensions. It generates opportunities with the reconciliation of economic activity with the management and strengthening of environmental protection, as well as investments in agricultural technologies that allow the use of natural resources in a sustainable way. This will result in a low-carbon economy and investment in renewable energy coupled with new sustainable consumption and production patterns.

Environmental or ecosystem services are considered to be the features offered naturally by ecosystems, but can be maintained, improved or restored by human action, though always considering the conservation of environmental conditions for a good quality of life. Thus, these services refer to the benefits that people get from nature directly or indirectly. They are of utmost importance for human well-being and economic activities and are based on the United Nations Convention on Biological Diversity (*CDB*).

Preserving ecosystems and environmental services is fundamental to human existence. Ecosystems are responsible for providing water and air purification. They soften violent weather phenomena and protect against natural disasters. They also decompose waste, maintain fertile soils and help control erosion. Animals, such as bees, pollinate plants that, while they are growing, sequester carbon from the atmosphere. Other animals, such as the agouti, help forests and forests by dispersing seeds.

Initiating an effective transition to a green economy requires the participation and investment of the public and private sectors in different areas, which include agriculture, energy, forests, tourism, transportation, manufacturing, and city infrastructure. Some of the green investments to be encouraged are renewable energy technologies, energy efficiency for housing and bioindustry, reuse of water, wind energy, efficient means of transport and clean energy sources for navigation are examples of actions that converge to the valorization and maintenance of ecosystem services.

Traditionally, areas with forests have reduced commercial value, due to the impossibility or restriction of economic use for enterprises. However, the evolution of world culture, international environmental commitments and recent legislative changes in Brazil and other countries in the region, have positively impacted the valorization of forested areas. The communication mechanisms and the academia report a significant number of transactions involving forest areas, as well as the increase in their price per hectare in the real estate market. Even so, the negotiations reflect *(a)* the acquisitions and real estate speculation of large institutions; *(b)* acquisitions or leases for the purpose of regularization of farms and other rural developments and *(c)* increasing demand from owners whose purpose is simple preservation. As such, although incipient, this indicates a path to be followed by the private initiative, but that makes the participation of the powers to be as the inducing agent of the process equally important. There is also the possibility that municipalities, states or departments, as public actors, may demand the payments for environmental services within their territories.

These trends with ecosystem services offer sustainable business opportunities for companies by generating new types of goods and services, within a green economy, which ensures the balance between economic growth, environmental assistance and social welfare.

The current markets, technologies and business models have promoted the emergence of biobusinesses based on the products of Amazonian sociobiodiversity. This entrepreneurial culture is characterized by the combination of technology, innovation, social responsibility and fair distribution of benefits with all actors in the value chains (*Nobre & Nobre, 2019*). Therefore, the perspective that the development of potential business in the Amazon requires transformations in the traditional economy lies in these future trends (*Abramovay et al., 2021*). This revolution requires a transdisciplinary approach, in which research and teaching institutions, entrepreneurs, producers, society and governments act in creative coalitions with the ability to transform scientific knowledge into business.

Considering these aspects, AmIT has the following objectives:

▪ Strengthen the environmental- and biological-based economy in the Pan-Amazon.

There is a range of already existing businesses that are extremely fragil, which represent a very small percentage in relation to the gross domestic product of the Pan-Amazon countries. The scientific technical knowledge about the asset to be traded and the negotiation strategies among the interested parties are important to transmit reliability to the market, and boost and expand the commercialization of Amazonian products and services.

▪ Structuring new bioeconomy value chains in the Amazon.

This objective is a response to the gaps existing in various aspects of value chains, technological, logistics and training issues that present demands for scientific-based investments, whose overcoming is essential to consolidate the opportunities for economic use of goods and services that can be produced in the Amazon. They are central questions, which need to be answered by science to override economic interests. Another important issue concerns the standardization of products collected and processed in a primary or more elaborate way. In all these stages, the training and professional qualification of the actors involved is fundamental for the consolidation of value chains beyond the supply of raw materials.

▪ Promote knowledge for new Amazon value chains.

The bioeconomy in the Amazon needs the researcher-entrepreneur-innovator and the formation of multidisciplinary scientific groups capable of effectively and efficiently relating to the business world. It is necessary to remove the barriers to the transfer of scientific and technological knowledge from the academic environment to the business environment and expand knowledge about strategies for the protection, commercialization and management of intellectual property assets (CNI, 2014). Businesses built on the pillars of ancestral knowledge, modern science, innovative business visions and the support of society can place sociobiodiversity as the protagonist of economic development in the Amazon. This change can empower Amazonian peoples by decreasing poverty and improving the quality of life of people in rural and urban areas, as well as ensuring healthy forests and rivers.

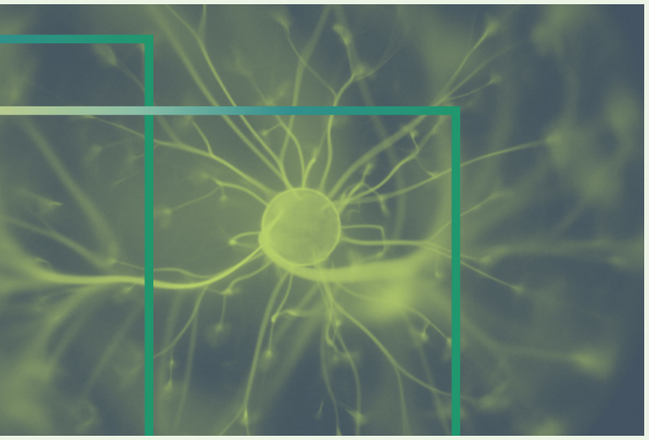
▪ Induce creative coalitions for high-value-added businesses based on Amazon biodiversity.

No economic sector is immune to the impacts of climate change and it will be necessary to change the socio-economic system, since the current one is not sustainable even in the short term on a planet with finite natural resources (*Viana, 2021*). The transition to a more sustainable economic system that uses the planet's natural resources more intelligently and efficiently and reduces social inequalities is urgent. The ambition to constitute a vibrant bioeconomy sector — based on its comparative advantages — will be modulated by the constraints on the knowledge level; by the challenge of establishing an advanced Pan-Amazonian regulatory framework for science, innovation and production; and by the surrounding conditions capable of boosting a still fragile base of enterprising and innovative scientists and technologists (Viana, 2021). The development and reindustrialization of the Amazon region by the bioeconomy will require the convergence of action of the state, the private sector and scientific institutions.

Implementation strategies

Although the Amazon represents most of the South American territory, it has high rates of social inequality and poverty. The consolidation of a broader and diversified economic model that increases the economic activity of the interior, which uses existing natural resources and guarantees the environmental and ecological services of the forest should be sought in the face of the tragic scenario in the economic, social and environmental field in the regions of the countries inserted in the Pan-Amazon.

The focus of this component is the decentralization and diversification of a forest-based economy in the Amazon region, which strengthens or creates conditions of permanence for companies installed in these chains. In this sense, it is necessary to work concurrently in the following structuring axes: aid to the development of an environment favorable to innovation that allows us to attract companies and/or institutions that generate employment and income; implementation of a network of suppliers and providers of goods and services with technical qualifications; and stimulation of low complexity enterprises, preferably in cities close to the origin of the raw material, which increases their technological density through the innovation of processes, products and services and the training of entrepreneurs.



Biodiversity will be the most promising source of wealth and value generation in the coming decades. In the Amazon, in addition to this competitive advantage, the availability of land, water and sun incidence will be the basis of a type of regenerative, circular and sustainable economic activity. The new and advanced cultivation techniques with increased organic products will drive the sustainable economic transition, which opens a unique opportunity for the Amazon, including that of agroecology. The current context requires an urgent effort to adapt economic processes because, with the climate crisis and the advance of deforestation, the risk that these resources will be lost is real.

The analysis of the functioning of the value chains already established in the Amazon allows us to detect the fragmented segments that need actions to function according to the principles of the new bioeconomy. In this sense, it is important to prioritize and accelerate business (Amazon marketing) based on a truly accessible market and promote the development of technologies for the use of forest knowledge and biodiversity. It is also important to promote a line of innovation for biobusiness models related to the identification of natural resources and processes with potential economic value. For example, the creation of hydribusiness, through water treatment technologies or even the generation of new energy sources, should be stimulated.

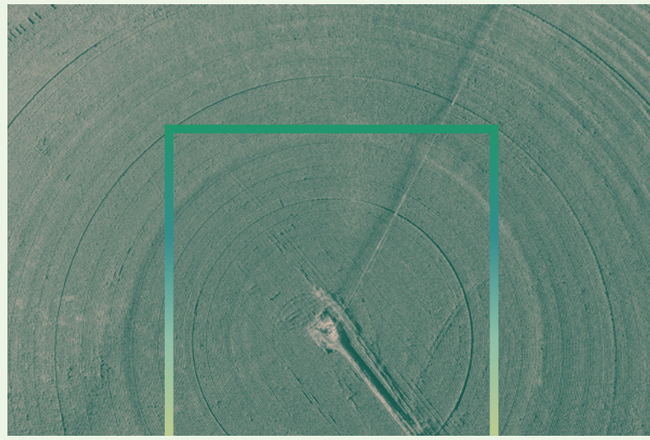
AmIT must adopt different strategies and scales in business to promote creative and highly customized products and services targeted at specific niches. Current technologies allow direct interaction between producers and consumers, business-to-consumers (B2C), in a scheme without intermediaries. At the same time, considering a broad portfolio of enterprises developed in the business-to-business (B2B) model, this may include the production of compounds for fine chemistry and specialized consulting services for different companies. As an instrument for socio-environmental development in the Amazon, biotechnology should represent a significant portion of economic production, guided by sustainability principles, which involve the analysis of new production processes.

The methodology for surveying the potential of investments and the current situation of the environment in ST&I in the Amazon as a converter of forest products into bioproducts should be based on the innovation model. In this model, natural environments, society and the economy should be seen as engines of knowledge production and innovation for social and economic development. Thus, the participation of laboratories, institutes and universities is fundamental in expanding knowledge about the nature assets of the main products of the Amazon. In addition, with the necessary equipment and training in advanced technologies, these institutions can contribute to the bioprospection of other resources that are still poorly studied (Abramovay et al., 2021), but in tune with the demands of the market and the problems of society.

This new vision should also focus on training capable entrepreneurs that are bold and sensitive to the problems of the Amazon. They must act in line with the evidence of traditional and scientific knowledge, but with deep empathy in the face of the reality of the Amazon. In addition, they need to have an innovative and adaptive vision to transform knowledge into successful business. This includes the management of marketing, investment, computational and informatics, among others.

Robust work with a collaborative coalition that involves several segments is also necessary so that the economy generated in the Amazon region has bases in its biodiversity and in the environmental services produced by this precious biome. This is a factor that demands strategies in the conduct of exploration and the market, because the designation of traditional products, by itself, does not present a guarantee of sustainability.

It is also appropriate to do a prospecting work with advanced techniques that can quickly provide indications of goods and services traded in the Amazon. Prospective analyses should be broad and consider an eventual market and the necessary processes to make the Amazon product competitive and with a quality that meets the demand of national and international markets.



In this way, in the initial phase, it is intended to choose products not yet consolidated, but that already have a certain technological level in their production and processing, and known markets to add knowledge that solve bottlenecks and influence good negotiations. In this context, logistical aspects are included that consider the types of products marketed and the difficulties existing in their production, processing and marketing.

Development requires exactly something

that enhances transformations and induces truly enabling options for a more promising future. It is necessary to value existing socio-cultural and environmental characteristics and living social forces, as well as to promote greater articulation of regional structures with national and international circuits, in order to intensify commercial and financial flows and cultural, scientific and technological exchange.

Thus, the development of technologies for the use of forest products and services requires project arrangements that involve institutions of different national levels, which can promote the development of research of economic interest or increase the bioeconomy. In this way, AmIT will contribute to increase the sustainable economic activity of the forest to provide the development of local human potential and, through technology, always seeking the least possible environmental disturbance.

In the context of the activities proposed by AmIT, it is important to emphasize and discuss the Amazon bioeconomy on the agenda of a "Pan-Amazonian Policy of Payment for Environmental Services" that will allow, in a transnational way, the actors of the value chains to adopt ecological actions in the management of the forest and its environmental resources in exchange for resources. This concern with ecosystem services has always been seen as an obstacle to investments, but it is necessary to reverse this scenario by adopting ecological actions in exchange for financial resources.

There is a tendency for private organizations to be primarily interested in joining payment systems for environmental services. It will be possible for certain companies to buy inputs whose production chain is sustainable, which adds value to products and can become stamps, and remuneration can be made through payments, discounts, exchanges and other benefits provided to participants in value chains.

Thus, different forms of these services may occur, such as (a) provision services with products obtained from nature, such as food, fresh water and timber; (b) regulation services from the regulation of the environment made by ecosystems and/or living beings involving the absorption of CO_2 by photosynthesis of the forests; (c) cultural services are those intangible benefits obtained from contact with nature that contribute to culture and social relations and (d) support services that contribute to the production of other ecosystem services, such as the maintenance of riparian forest or seed dispersal.

This will stimulate a kind of "green market", in which forest producers will offer projects and the companies interested in these environmental payments will choose which ones interest them. To apply for for the support of a public or private body, the producer must look at his property, which implies a kind of "self-regulation" regarding the conservation of the property in order to obtain financing for his/her economic activities.

Priority action:
Income generation based on Amazonian environmental assets

WHAT?

Contribution to reducing the fragmentation of bioeconomy value chains and improving the value of environmental services.

HOW?

Prioritization and acceleration of business (marketing) based on accessible markets and development of technologies for the use of forest knowledge and biodiversity.

WHERE?

Establishment of actions prioritizing locations with investment history and observing their cultural vocations.

Component 9

RIGHTS OF THE AMAZON BIOME

Context

The Amazon does not have a birth certificate, it is estimated that it is about 65 million years old. Amazonian species do not use passports to transit from one country to another by land, water or air. Rivers in the Amazon basin do not need an environmental license to establish or change their course. The Amazon biome, in all its grandeur and complexity, is unaware of geopolitical borders, environmental laws and international treaties created by humanity over the last 4 thousand years.

It is undeniable, however, that the entities of nature suffer directly or indirectly from the impacts of legal systems. In this context, the question of the sovereignty of each country and its natural resources, the right to the development of local communities, indigenous, traditional and quilombola peoples, as well as the prior and reasoned consent for access to biological material are included, for example (*Platiau & Varella, 2004*).

Currently, nature is conceived, valued and protected according to an anthropocentric logic, without its own rights. Society confers value and manages the environment as a set of entities of nature devoid of legal personality. This is reflected in the economic value attributed to natural resources, environmental assets and the award of property rights over natural spaces.

However, the environmental crisis, which is perceived through climate change and intensified in recent years, shows that conventional responses in the field of environmental policies and legislation have been insufficient. The recognition of rights to nature has been part of the paradigm of many indigenous populations for centuries. However, these principles were not incorporated into the development of modern environmental laws, which are based on anthropocentrism (*Pecharroman, 2018*). Only in the last 50 years have new paradigms began to be envisioned to legitimize the rights of nature.

The movements for a legal basis capable of regulating the rights of nature gained strength with the Convention on Biological Diversity during ECO-92, one of the main international instruments of environmental protection, which has an emphasis on the control of access to genetic heritage and other related terms. In addition to the lack of long-term strategic planning, the different regulatory obstacles in the interaction between academia and companies possibly constitute the main determinant of the low level of intensity that we still observe today (*Mello & Sepúlveda, 2017*). After 24 years of the creation of the Amazonian Cooperation Treaty Organization (*ACTO*), which is endowed with a

supranational legal personality, the consolidation and regulation of a legal framework for the Pan-Amazon continues to be a challenge to ensure a fair socio-environmental development in the region.

In traditional justice systems, precedents for the recognition of the legal personality of entities of nature, such as rivers, forests or coral reefs, are still rare. Nevertheless, the concept of "right to full respect for the environment" proposed by the American judge Christopher Stone in 1972 has gained increasing relevance and repercussion, especially in Latin America (*Tanasescu, 2017*). Currently, the Ecuadorian and Bolivian constitutions explicitly recognize the rights of nature, such as the right to its existence, maintenance, structure, functions, evolutionary processes and regeneration of life cycles. In Panama, these rights were recently recognized. This approach represented a breakthrough in granting positive rights to nature, which can be demanded by every person, community, people or nationality.

This opens new avenues for thinking about the future of law, such as the possibility of a lawsuit filed on behalf of a natural entity that has suffered damage. The concrete paradigmatic case of the Vilcabamba River in Ecuador stands out. In Brazil, there is an attempt to recognize the environmental rights of the Doce River (Minas Gerais and Espirito Santo). However, the Pan-Amazon and its ecosystems have not yet had effective legal processes put in place that recognize them as subjects of law. Strange as it may seem, to attribute a legal personality to a being of nature in no way differs from other legal fictions such as the institutes of the joint-stock company, the bankrupt estate or the estate.

Furthermore, the law has already advanced to the point of even giving rise to the recognition of subjective rights to artificial intelligences or decentralized autonomous organizations (*DAOs*) formed by sets of smartcontracts on blockchain networks. In this context, the use of innovative technological arrangements appears as an element to strengthen the possibility of guaranteeing legal personality to entities of nature, not only as a passive part, in cases of environmental damage, but, above all, including them as active agents in investment funds or members of corporate companies.

The environmental challenges faced by different countries are becoming increasingly serious. The emergence of a process of internal reception or integration of environmental objectives appears equally at the level of technological and product innovations, as well as in terms of political processes and their respective instruments (*Lacroix & Zaccaï, 2010*). Given the complexity and scientific uncertainty regarding the irreversibility of environmental impacts in the Amazon, the answers to the problems raised here go through the Constitution and recognition of the rights of nature that allow its inclusion in the management processes of the environmental assets generated, through ecosystem networks and international mechanisms of nature protection.

In view of the aforementioned legal innovation, AmIT aims to:

- **Establish new paradigms of law in relation to the Amazon environment.**

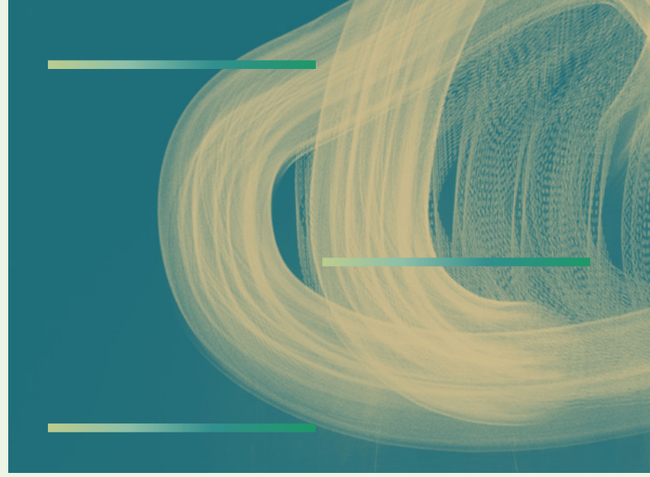
There are numerous specificities in the legal systems of each of the Amazonian countries, with differences in the very conception of justice and legal personality. Thus, the creation of innovative and integrating legal devices that promote legal certainty, the balance between the use of natural resources of the Amazon biome and the integral respect for the rights of nature is a horizon to be pursued.

- **Develop legal frameworks for use, conservation, protection and social inclusion in the Pan-Amazon.**

The justification of environmental damage under the aegis of diffuse social justice tends to perpetuate social inequalities rooted in development models based on high environmental impact activities, such as mining and illegal logging. Thus, ecological justice is not opposed to justice among humans, both complement each other in such a way that full justice is only possible if it is achieved in social fields.

- **Innovate the legal bases for socio-environmental negotiations in the Pan-Amazon.**

An innovative legal vision is needed to make the Amazon a direct beneficiary of its wealth, being itself responsible for the equitable distribution of its assets in order to ensure their preservation and environmental health. As geographer Berta Becker predicted: "the South American Amazon could be able to effectively make water a common good for the regional and world population, through the commercialization of management techniques and methods developed in peaceful cooperation." (*Becker, 2003*).



Implementation strategies

The Pan-Amazon is an environmental and biological complex in its broadest sense and its conservation is of common ecological, social and economic interest to the planet. Achieving this initiative will require an effort to build supranational channels of normative dialogue between the countries that integrate it, in order to ensure legal certainty for a wide spectrum of economic and scientific activities that will be carried out in the region.

In strategic terms, the first step should be to build the legal framework that regulates various aspects of environmental law and its interactions with other legal branches. The knowledge and analysis of the legal institutes of the nine countries that make up the Pan-Amazon is essential in order to understand the possible gaps, overlaps and points of convergence to advance the constitution of the rights of nature. Environmental and legal interdependence should be a guide for the study and design of legal institutes and regulatory frameworks.

The Amazon Cooperation Treaty was formulated, signed, ratified and promulgated in 1978, with the aim of consolidating an integral and sustainable development of the respective territories of the Amazon, and the member countries took into account the need to maintain the ba-

lance between economic growth and the conservation of the environment.

However, each ACTO member country adopts a different approach to the Pan-Amazon, according to its own ecological (or biogeographic), hydrographic and political-administrative criteria. This diversity of legal systems poses challenges for the effectiveness of projects and the execution of strategic plans in the region, including the lack of sharing of technological, scientific or educational advances.

Another serious problem that presents itself is the low integration between the nine Amazonian countries. Although ACTO facilitates cooperation between these countries for sustainable development, based on transdisciplinary scientific bases, with the purpose of establishing itself as a forum for dialogue to coordinate the integration of transport, energy and communication infrastructure, little progress has been made in the last two decades.

In this sense, the Leticia Pact, signed in 2019 by seven Amazonian countries, may mean a new opportunity to reinvigorate the purpose of Pan-Amazonian regional integration. The signatory countries of the aforementioned pact have established sixteen points that include combating deforestation, forest restoration initiatives, sustainable use of natural resources, strengthening of women's rights and of Amazonian peoples, and creation of educational campaigns, among other points. The participation of AmIT in the presidential summits of the Leticia Pact may contribute to the construction of strategies and targets based on scientific evidence for the sustainable development of the region.

In the current scenario of market globalization, the formation of a common culture of protection and joint promotion among the peoples of the Pan-Amazon remains substantially weakened, which hinders the solidarity and shared work of their states and peoples in favor of the realization of their common interests. Therefore, AmIT's work, combined with public policies and civil society awareness, can contribute to the formation and affirmation of the international identity of the Amazon, supported and amalgamated by the rights of nature.

Efficient collaboration in the region should involve the Amazon countries as well as other countries. The conservation of the Amazon rainforest, combined with the legitimacy of the sustainable development of the peoples who inhabit it, permeates the continental interest and must therefore be the object of synergy of the local, regional and national governments of the Amazon, and with real participation of the communities that live in it.

In this scenario, the harmonization of legislation and management of the Amazon by the states of the region, observing the geographical, sociological and economic particularities, is essential. The compartmentalization of legal systems only promotes chaos and ends up benefiting vested interests in the region, which puts at risk the survival of indigenous and traditional peoples and the Amazon biome.

It is, therefore, an ambitious multi-faceted project, with challenges imposed by the requirement of cooperation among its members. This is necessary for the promotion of scientific and technological research, on a safe and reliable legal basis, the rational use of natural resources, the promotion of business and the conservation of nature, the latter being recognized as a subject of rights. ■

Priority action:
Innovation of the legal ecosystem for the Amazon

WHAT?

Constitution of legal personality for entities of nature in the Amazon biome.

HOW?

Adoption of technologies, such as blockchain and smartcontracts, to accelerate the process of recognizing the rights of entities of nature.

WHERE?

Adaptation of national and international avant-garde experiences to the Amazon as sources of the rights of nature.

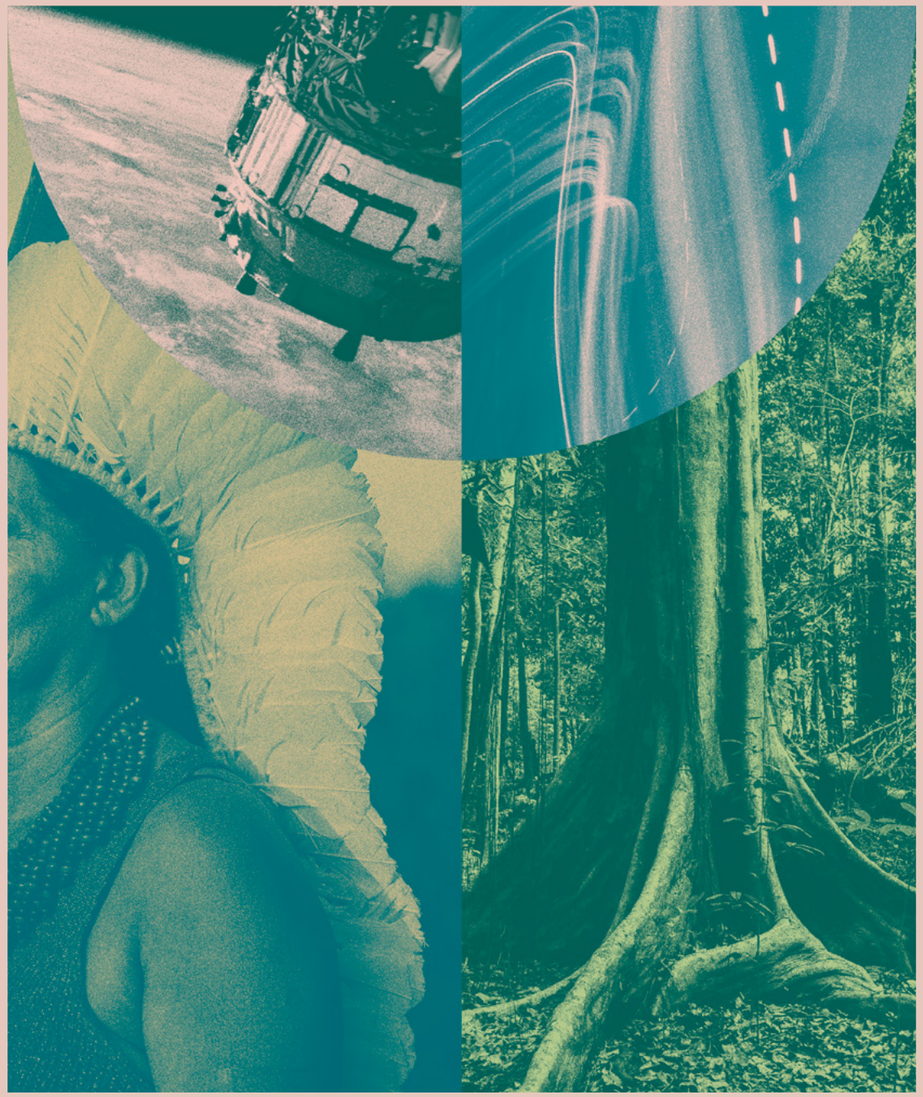
THE NEXT STEPS

The transversality of the nine components, at different level of influence, in the context of each of the five centers, will depend on a **feasibility study** that must contemplate the complexity and social, political and environmental specificity in each Amazonian country to give life to an integral study on the Pan-Amazon. Equally, the work team should have at least one specialist in each component, in addition to specialists in the social, statistical and economic areas. Everyone should have a broad knowledge of the Amazon reality.

The purpose of these studies is to recognize the *strengths*, *opportunities*, *weaknesses* and *threats* in each Amazonian country and at the Pan-Amazonian level for the integration of components and centers. In this way, it will be possible to decide, for example, which components should be prioritized, which should be expanded and which should include aspects not foreseen in this document.

7

GOVERNANCE



GOVERNANCE

The organizational structure of AmIT is designed to include **flexibility and dynamism**, which are characteristics that are inspired by the relationship of the Amazonian man and the forest. This relationship between *man* and the *forest* allows the generation of immeasurable knowledge that can integrate perfectly with modern knowledge through dialogue in order to generate actions in the face of the challenging scenario of the current world.

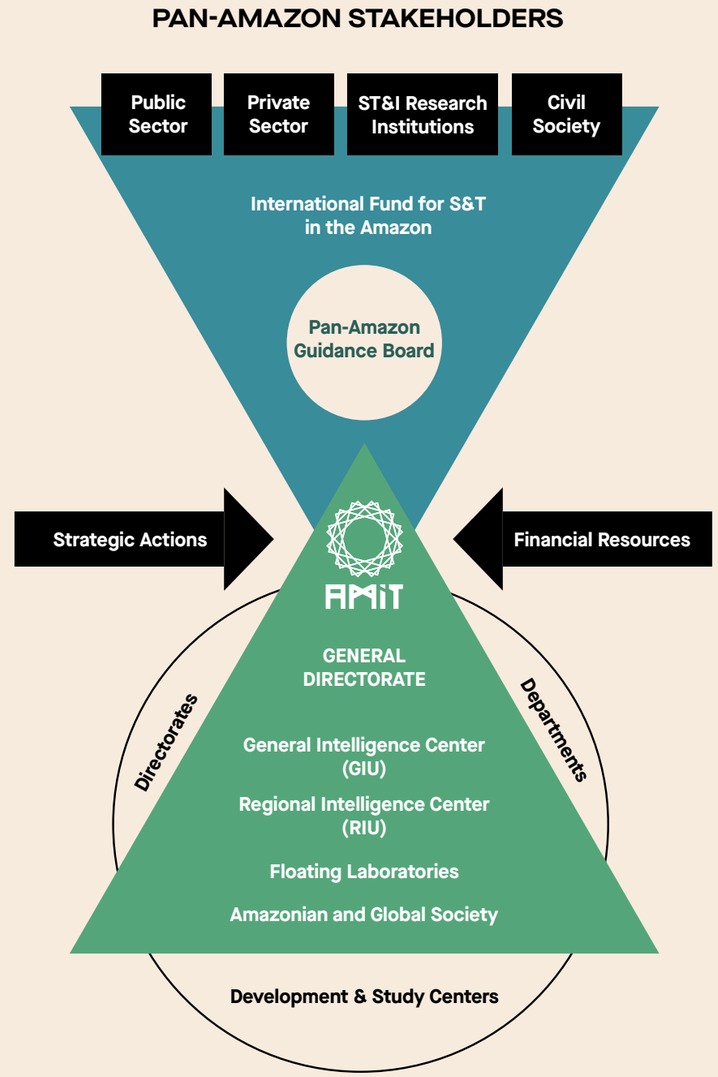


Figure 8. AmIT dynamic organizational chart.

AmIT will be a public-private institution of Pan-Amazonian reach, observing the laws of each country, but maintaining supranational characteristics. *Figure 8* describes a general dynamic governance structure that includes representatives of governments, intergovernmental institutions, universities, institutes, companies, other private sector organizations and civil society that will form AmIT's governing board.

The board has the role of guiding decision-making, which includes the application of financial funds. To this end, it is planned to create an international fund for science and technology in the Amazon with regular donations from Amazonian countries and it will be able to receive resources from foreign donors. The application of financial resources will be made by AmIT's general board, heard by the guiding council, through strategic actions that meet the mission and vision of AmIT, and directed to the Amazonian society and to global perspectives.

AmIT's operations will be carried out through a unique and unprecedented system in the Amazon, taking advantage of the Amazon River and its tributaries in a context of accessibility, mobility, flexibility and connectivity. AmIT will work in constant exchange of local knowledge and innovative technological solutions to the main problems that the Amazon society faces in all its aspects, as well as environmental conservation actions. The fundamental purposes will be the strengthening of value chains in each micro-region, the conservation of forests and rivers, social inclusion and quality of life.

The structure proposed for this purpose includes a **general intelligence unit** (*GIU*), located in Manaus, interconnected to the **regional intelligence units** (*RIUs*), which will be located in the Amazonian countries forming the main nodes of the AmIT action network. The GIU will include data processing as well as the curation system and unique and special equipment. The other RIUs will be equipped with state-of-the--art advanced technology laboratories and computational centers and will have the leadership and participation of technicians, researchers and scientists of the highest prominence in their areas of expertise (*Figure 9*).

The exchange of knowledge will be made by "floating bases" designed following the principles of biomimetics and energy autonomy. The **"floating bases"** will be equipped with state-of-the-art technology and accommodation to receive researchers, technicians, fellows and the people responsible for maintaining the infrastructure for long periods. These "floating bases" will be spread across the rivers in the Amazon in the micro-regions and connected primarily with the RIUs and continuously to the GIU in Manaus. The bases will receive the demands and must propose the first solutions.

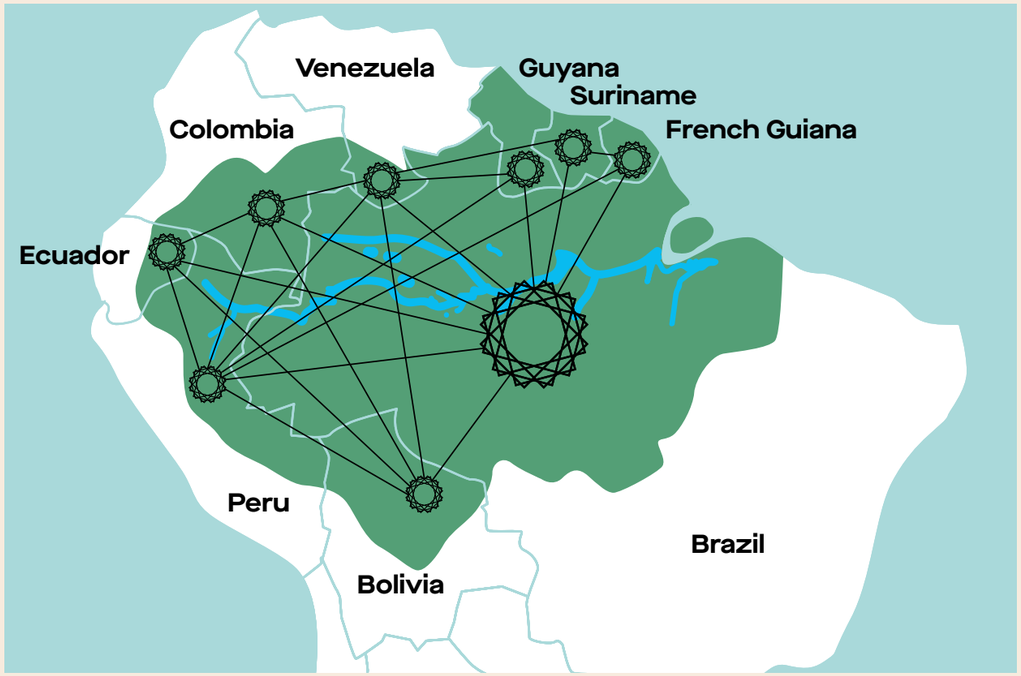


Figure 9. Representation of networks and integration generated by AmIT.

The system will work following the representation shown in *Figure 10*. The "floating bases" will be in constant exchange of knowledge with the communities of the micro-regions within their area of action. In this interaction, the needs for technological solutions in value chains and other activities will be detected within the nine components foreseen for AmIT's activities, as previously presented. In case 1 (*left side of Figure 10*) the team of the "floating base" detects a need and works to generate a technological solution and bring it back to the community. Subsequently, it sends its reports and collected data to feed the knowledge system operated by the RIUs and GIU.

Case 2 (*right side of Figure 10*) illustrates a situation in which the "floating base" needs greater support from the intelligence unit to solve the problems of the community. In this case, the problem will be passed on to the RIU that will produce solutions in its facilities and can trigger the other RIUs, the GIU or even the international network, if necessary. In possession of a solution, even if partial, the information operated at a distance will be made available to the community. This constant and multidirectional flow of information will contribute to the formation of a super database that can also be operated remotely by the "floating bases".

The system should also allow remote experimental operations and tests. This helps to reduce the distances imposed by the meandering rivers existing in the Amazon. In this context, the processes of environmental conservation can use state-of-the-art technological applications such as machine learning to, for example, collect samples and meet health-related demands, among others.

As reported, AmIT's operation is characterized by a strong component of networked and

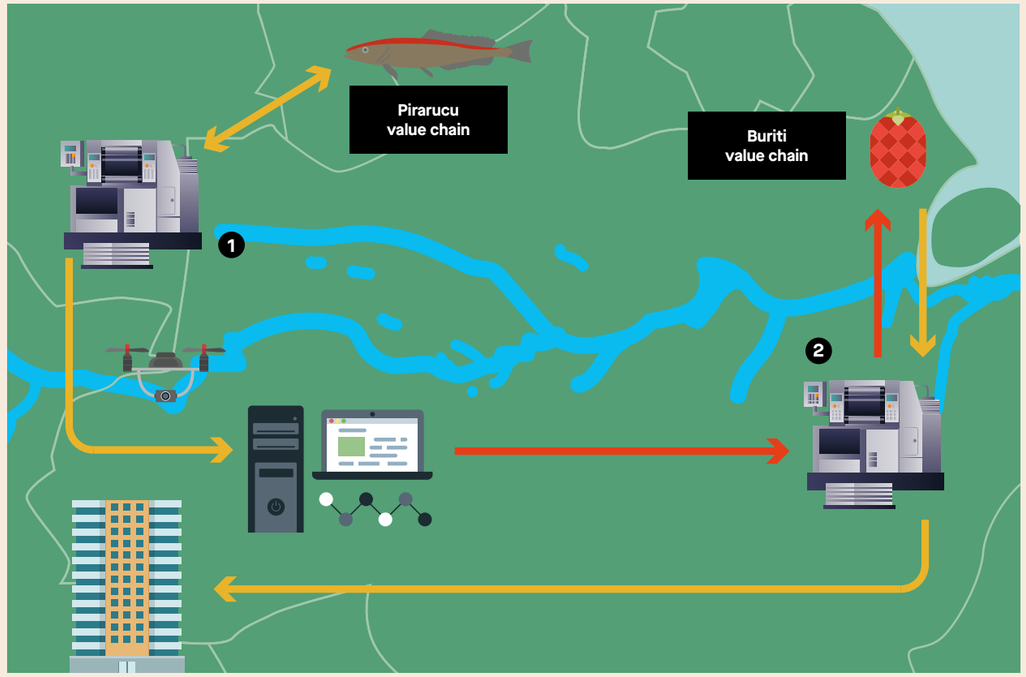


Figure 10. Flowchart of the functioning of the AmIT using the Amazon River as an artery of knowledge.

remote actions. In this horizon, all kinds of technological innovations will be prioritized. One of these innovations will be the use of autonomous drones with specific modifications that allow the collection of samples of plants in the forest canopy and insects through a specialized trap. The collections are not limited to the aerial scope of the canopy, since aquatic collections will also be carried out with equipment adapted to the conditions of waterbodies. The soil collections will be carried out by hybrid drones, with the ability to fly and descend to the collection point (*Figure 11*).

To ensure the quality of samples during transport, specific tests will be developed on materials where samples will be deposited. Remote collection systems will accelerate the advancement of science, which allow genetic and molecular studies aimed at monitoring biodiversity and environmental health, prevention and control of diseases and zoonoses and the discovery of potential answers and technological solutions that can generate patents and sustain biobusiness. Finally, these systems can serve as models for the collection, transportation of exam samples and medicines in remote areas of the Amazon.

AmIT proposes a new way of "doing" science that is aimed at **solving problems through the potential use of Amazonian knowledge.** In addition, it will be able to provide solutions to local and global problems and inspire other regions of the world through its initiatives. This new way of intervening and interacting requires trained people at all levels. A more general level is the preparation of communities to appropriate information that enables income generation, social inclusion and environmental conservation. The diversity of media and media can contribute to the comprehensiveness in this case. Further training will be required so that people from local communities can interact with the "floating bases" and operate equipment for collecting information. Such personnel should have the ability

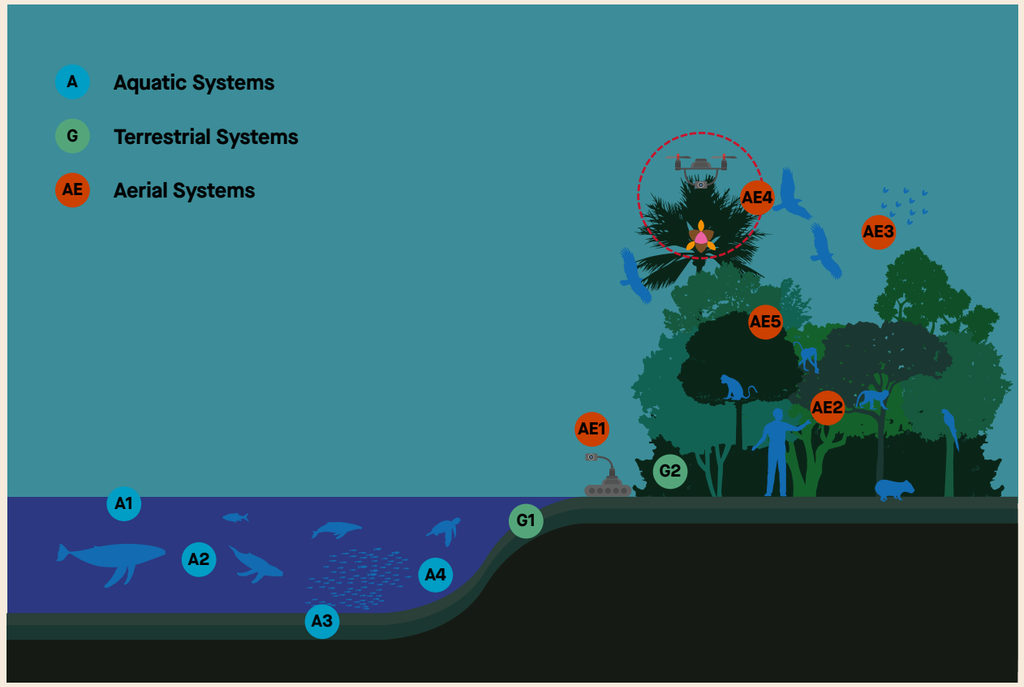


Figure 11. Operation of the remote biological and environmental collection system.

Source: KAA Iniciative

to bring problems to the lab benches and assist in the transfer of information to communities.

AmIT will also be a different environment for graduation in various areas of knowledge since the training will take place in the environment in which it is required. For this, state-of-the-art scientific environments and "floating bases" in the different micro-regions of the biome will be used. The exchange of students and professionals will simultaneously enrich the training of students and visiting scientists.

Finally, the structure of AmIT will be a special option for graduate students and post-doctoral students to work on the frontiers of environmental and social challenges. The functioning of the institute in a regional, national and global network will bring the credibility and possibility of the exercise of multi- and, mainly, interdisciplinarity for the solution of the multi- and interdimensional challenges that the Amazon biome and its inhabitants continuously present. It should be noted that, in the current scenarios of environmental changes, these challenges gain new and more challenging contours for science.

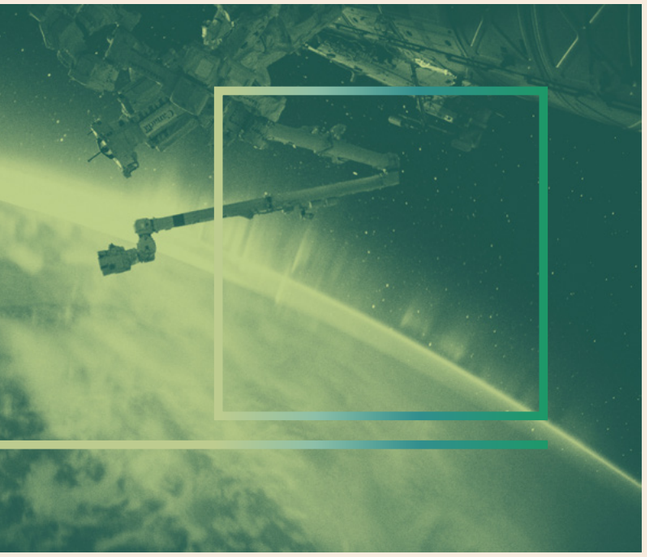
Interinstitutional cooperation

Symmetrical institutional cooperation is the key word within AmIT and should take place at all levels of the institute's organization, in all geographic regions of the Pan-Amazon and at the international level. This will be achieved through the "floating bases", the RIUs and the GIU, which are strategically distributed in the region and hubs abroad. It is interesting to structure a first point of contact with the outside via MIT/USA. Through **self-directed neural networks** according to the challenges that arise, it will seek to produce information that allows the prompt decision-making and empowerment of local communities. These decisions must reconcile the knowledge of the Amazonian peoples and the academia to ensure the stability and improvement of local economies, as well as actions for environmental conservation and quality of life.

With regard to AmIT, the interinstitutional cooperation made possible by the aforementioned network, should allow students from the most different Amazonian and world institutions to interact with the institute's researchers, as well as use the infrastructure that must be implemented.

The cooperation network with AmIT should be structured around the nine previously presented outlined components and the general (*GIU*) and regional (*RIUs*) intelligence units. Attachment 1 lists the Pan-Amazonian and international institutions that can be part of this network and, through AmIT, connect to the worldwide networks via MIT and USP. The organization and administration of this network should involve artificial intelligence in such a way as to quickly bring into contact laboratories and scientists who have studied or are studying the challenges being considered. It is not, therefore, a mere connection between institutions, but rather an optimized intelligence network.

The operationalization of an intelligence system in this way requires state-of-the-art technology and MIT will be able to effectively contribute to this. Part of this operationalization will have to be robotized and will necessarily need an independent and available satellite band without limitations.



Data-logging system

Knowledge is the product of the analysis of data obtained through observation and experimentation. In this sense, the quality of data and metadata needs to be guaranteed since its acquisition in the field or in the laboratories to its final disposal in AmIT's repositories. This is of immense importance, as AmIT aims to create a **megabank of data** of a diverse nature; i.e., data from biological, environmental, social, economic research, produced by researchers, members of local communities and civil society in general in the context of citizen science.

AmIT provides for collaboration with specialized researchers and experienced scientists in data governance for the specific objectives of each research area provided for in the components of this proposal. This governance will be constantly evaluated to establish critical points that should be improved with feedback from data collectors and analysts. The objective in this case is the replicability and availability of data so that other projects generate knowledge.

Collaborative scientific production

AmIT proposes to create a strong network of intra-regional, regional and international symmetric collaboration in scientific production. The interaction of these research networks needs to prioritize effective actions to strengthen Amazonian science. Although much of the funding for research may come from institutions in developed countries, it is necessary to **change the role of the Amazonian and Latin American researcher** from being a simple information collector to being project coordinator. Research products should directly benefit local institutions, the Amazon society and biome conservation, thus contributing to a healthier world environment.

A simple diagnosis of practices in scientific production in the Amazon allows us to verify that the role of indigenous communities has been limited to the object of study or assistance in fieldwork, often using traditional knowledge as a fundamental part of research. AmIT proposes to produce science in an integrative way that promotes the training of indigenous researchers for their empowerment in the Amazon.

Financing of the symmetrical relationship

AmIT seeks to re-signify the traditional relations of non-symmetric international cooperation that establishes a **verticality between donors and recipients**. This model brings autonomy to donors over the design and implementation of projects, which limits the empowerment of local science. In the global scenario, alternatives to this model that seek a horizontal system of symmetrical relationships between donors and recipients have been discussed, which should result in the reduction of political, scientific, social and economic inequalities.

AmIT proposes the creation of an agenda of annual meetings in the different levels of action, which should include meetings, seminars, technological innovation fairs, at the intra- and interregional levels with the participation of members of the guiding board, government officials, researchers, entrepreneurs and society in general. This agenda will strengthen the relations between researchers and society for the socialization of projects that promote scientific autonomy within the Amazon. To this end, AmIT will manage through the International Fund for Science and Technology in the Amazon the financial resources raised from foreign institutions and the Pan-Amazon.

Risk

There are several threats that can compromise the success of AmIT's goals. Thus, it is imperative to develop a **detailed risk matrix** to develop an action plan that guarantees the success of the development of the projects proposed by AmIT.

Mistrust is the first and greatest risk that can compromise AmIT's sustainability. Losing the trust of donors, peers or society will lead the institution to failure. Projects must be long-term with robust investments and involvement of various economic and social agents. Insufficiency, uncertainty and/or discontinuity are risks that can seriously compromise the existence of AmIT. It is necessary to objectively identify the risks that can promote distrust and know how to mitigate them.

The risks related to mistrust in teaching and research activities can be caused by the following reasons: inadequate application of financial resources; lack of transparency among project stakeholders; failure to adequately respond to commitments made with donors; non-compliance with the tasks assumed in the agreements and disrespecting the sovereignty of the RIUs in relation to legislation and the social and institutional culture of the location.

Other technical, legal, political and macroeconomic risks can be listed, since there are different situations for each of the aforementioned items, which must be worked out in all Amazonian countries. Some of these risks are outside the domain of AmIT, and it is necessary for the institution to know how to work with differences, recognizing the responsibility of each partner in building transparent management that is light and focused on the results agreed with the investors.

In this case, in particular, a specialized consultancy is recommended in order to develop a technical and well-structured model of the institution for the assembly of a risk matrix, considering the identification, prevention and definition of action protocols for each risk.

Compliance program

The institute has a complex governance that involves stakeholders from different backgrounds and cultures, which makes this project extremely sensitive to risks that can compromise its success. Therefore, a quality compliance program relating a set of AmIT actions and conducts is necessary to conform to the rules and norms defined by laws, regulatory bodies and internal and external standards. Although it may seem excessive to use resources with a compliance program, its return brings significant impacts as exemplified:

- **Process standardization and continuous improvement**
- **Risk management**
- **Increased efficiency**
- **Transparency**

The standardization of AmIT's processes will guide all actions of the institution with the objective of being more efficient and with fewer errors. This will also facilitate employee engagement through open stakeholder dialogues. AmIT's process transparency will gain employee loyalty with a clear management model for everyone involved in the process.

Performance evaluation

AmIT shall undergo a five-year evaluation carried out by an international high-level commission that will consider the social and environmental impacts of the activities carried out. Accountability should be strictly specified and assessed by the commission. Intraorganizational relationships should be evaluated by monitoring the indicators proposed by Gummesson (2005): information exchange, trust, commitment, cooperation, satisfaction, loyalty and power. In addition, the management of financial resources should be evaluated. ■

8

PROJECTION OF RESULTS

PROJECTION OF RESULTS

CHARACTERISTICS OF AMIT AND ITS SOCIO-ECONOMIC BENEFITS

AmIT is a *public-private organization* whose main activity is the social function of forming critical mass with the ability to **analyze and provide solutions** for Amazonian problems, in addition to producing and transferring knowledge to the various socioeconomic segments that are part of the Pan-Amazon countries. Its main raw material is the Amazon biome.

© Neil Palmer

Therefore, the institute should develop its activities in a covering area of 7.8 million km2, including nine countries with an estimated population of more than 50 million inhabitants, which includes indigenous and traditional peoples. This implies that its target audience has competitive differentials that need to be considered in their way of acting, with attention focused on political, economic, cultural variables and the different opportunities and threats to existing businesses in the region.

Thus, in order to respond to the challenge of acting in the whole region quickly with the inclusion of local populations in the qualification process, AmIT proposes to contribute "*floating bases*" in the places of study interest.

An essential condition to be used by AmIT is the human intelligence existing in the educational and research institutions of the Amazon. Developing local collaborative activities, considering this intelligence, should strengthen and expand the number of researchers and professors in order to understand the dynamic processes that govern the Amazon biome and stimulate the implementation of new businesses involving biodiversity and environmental services. For this, using advanced technologies for teaching, research, extension, innovation and entrepreneurship activities is essential and should rely on MIT's experience in a two-way process. Training staff and producing the necessary information in a collaborative process will contribute to the sustainable development of the region.

The institute has as its ethical and moral principle the conservation of the Amazon biome, and this is possible with the qualification of personnel from the region to use its resources correctly. The products to be generated on a priority basis by AmIT can be summarized as follows:

- **Integral health**, for people and the environment;
- **Production of knowledge** about the use and conservation of natural resources of the Amazon biome.
- **Empowerment and socio-economic inclusion** of the population through the use of natural resources and technology;
- **Education**, qualification and talent fixation in the Amazon;
- Providing **information and knowledge** about the Amazon biome to society;
- Designing innovative **business opportunities** for the bioeconomy;
- Contribution to **legal certainty** in biobusinesses and environmental services.

Budget

AmIT is an ambitious and bold project that seeks to answer the major socio-economic and environmental issues of the Pan-Amazon. With the intention of contributing to the social development of the Amazon region and, consequently, working with the cultural and economic plurality of regional societies, AmIT will count on building strong links with local, regional and international intelligences, thus creating an intelligence network for the development of collaborative projects. As previously mentioned in the strategies of Component 9 - Rights of the Amazon biome, the Leticia Pact represents an opportunity to strengthen an integrative and supranational network for the sustainable development of Amazonian countries.

Its implementation will take place in phases, which may, at some stage of its development, work concomitantly with investments in personnel and infrastructure. Initially, the task is the implementation of AmIT so it becomes a legal entity that can fulfill its mission. All legal aspects and the advantages and disadvantages of the different social organizations that are part of the list of public-private institutions existing in the Pan-Amazon will be studied. To this end, it is necessary to count on specialized advice that guides the most appropriate decision-making for what AmIT proposes.

At the same time, a process of identification and association of intelligences must be initiated in the technical-scientific reference institutions existing in the Pan-Amazon for the construction of the RIU network and form the first link for the definition of the "**floating bases**" in the different regions and the projects based on the components established by AmIT. This requires moving members of the AmIT group to different regions or micro-regions in the countries of the Amazon.

Thus, each country in the Amazon will have at least one reference point for immediate contacts and operationalize the actions envisaged in AmIT's projects. This can be a small office with access to direct communication with the other centers made up of specialized researchers and technicians, the "floating bases", the RIUs and the GIU.

With the confirmation of the understanding between the RIUs on the strategic places where the "floating bases" will initially be docked, a new phase of AmIT's implementation will be underway. This phase consists of the installation and rigging of the entire system; i.e., the consolidation of the link between the networks of the "floating bases", the RIUs and the GIU. Thus, visits to the sites where potentially the "floating bases" will be located, as well as analysis of the legal aspects about their anchoring, mobility and technical feasibility will be required. At the same time, it will be necessary to make the design of the laboratory and the description of its operability regarding its equipment, communication and personnel.

In the case of the state of Amazonas, specifically Manaus, the investment becomes greater because it is the home of the **general intelligence unit** (GIU), and because this place should be endowed with its own headquarters, with the possibility of physical growth for training in advanced technologies in the Amazon. In this place, the appropriate data processing center (big data) will also be installed to manipulate a large volume of data and implement a curatorship system of international relevance.

AmIT should also constitute a strong educational action with courses and programs for personnel training from undergraduate to postdoctoral level. As reported above, in Component 5 - Educational models (Figure 7), AmIT will dedicate specific areas of knowledge connected with the needs of the region. In this case, it is important to provide AmIT with the appropriate infrastructure to enable the execution of its educational and research services.

As action strategies, AmIT will prioritize nine reference components for the development of projects aimed at the social and economic inclusion of the Amazonian populations and the environmental sustainability of the region. These nine components will have their activities developed in **five specific development centers**. For this, consultancies are necessary for the preparation of calls with the requirements agreed with the peers of the different AmIT intelligence units.

The costs adopted in order to estimate the values of investments will be based on the market price in the city of Manaus, Amazonas. Following this, the table with the budget for the categories of investment, personnel, travel and per diems, consulting, research and network education, endowment to ensure the financial strength of AmIT, viability of partnerships between Pan-Amazon countries and financing through partnerships such as the financial collaboration via industries, universities and businesses in the implementation of AmIT's infrastructure is presented.

CATEGORY	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	SUBTOTAL (USD)
Investment	4,239,200	54,032,000	4,832,000	64,832,000	6,032,000	133,967,200
Personnel	2,117,500	2,592,000	6,941,300	9,400,800	10,477,500	31,529,100
Travel and per diems	1,552,000	1,552,000	1,552,000	1,552,000	1,552,000	7,760,000
Consultancy	10,000,000	0	0	0	9,000,000	19,000,000
Network research and education	50,000	49,200,000	49,200,000	49,200,000	49,200,000	196,850,000
Endowment	10,000,000	40,000,000	100,000,000	100,000,000	250,000,000	500,000,000
Enabling Pan-Amazon partnerships	500,000	500,000	500,000	500,000	500,000	2,500,000
Subtotal (USD)	28,458,700	147,876,000	163,025,300	225,484,800	326,761,500	891,606,300

Table 2. Budget for the implementation of AmIT

Revenue opportunities

Conserving the Amazon and simultaneously offering alternatives for **social inclusion and income generation** constitute the foundations of AmIT. Therefore, the returns from a large part of the resources invested in this project is to contribute to the safety of ecological services produced by forests and rivers for the planet and to the socioeconomic inclusion of the population of the region. This is expressed in the nine components that sum up the activities of AmIT, which are components that permeate five centers.

It is with this perspective that AmIT will seek to produce revenue that can contributes to the sustainability of the institute. For this purpose, we plan to generate partnerships and agreements with the main transnational companies in the area of technology and biotechnology, international development agencies, international foundations, and the Pan-Amazon Fund for S&T, among others (Attachment 2). Principally, this should consider three main lines:

© Neil Palmer

EDUCATIONAL LINE

In this line, we intend to create courses and programs for personnel training from undergraduate to postdoctoral level. Primarily, they are differentiated courses that take advantage of the opportunity of MIT's participation, with advanced technology courses that have a main focus on specific areas of Engineering, Biology and Biomedicine, Anthropology and Economics.
AmIT will produce and make available to society and socio-economic segments a set of technical training programs that are appropriate to the reality of the Amazon. All this within a process of accelerating the diffusion of existing knowledge and information that can be quickly made available to society.

CONSULTING LINE

The institute will offer innovative solutions and technological packages to socio-economic segments in the countries of the Amazon and, through consulting, will respond to demands in the region that have local, regional and even global origin.
AmIT will deploy a digital platform to support biobusinesses with the aim of making the institute an international reference through the production of reliable data. A large volume of data obtained in the development of AmIT's work will be available on this platform for people who are duly registered in the system and interested in the information contained in this database. The platform should store and make available scientific technical articles about the Amazon and its natural wealth.

PROJECT GENERATION LINE

An innovation and project generation agency should be part of the organic structure of the institute with the aim of identifying business opportunities, guiding and supporting the development of research and obtaining patents. It is important that the institute has the expertise to direct the main activities considering the nine components previously proposed. Based on this information, projects will be elaborated, offered in calls to be executed by specialized teams in conjunction with AmIT, which can also act as an agency that channels the financing of international foundations.

Aligning AmIT with new global conservation scenarios

The expansion of the agricultural frontier through monoculture systems for the production of commodities (soybeans, beef, palm oil, and coffee, among others) is one of the most important causes of deforestation and forest degradation in the Amazon. In the current bellic context, the restriction of grain supplies from Russia and Ukraine may encourage the search for new frontiers for agriculture. This situation would endanger the Amazon and other regions, thus intensifying the processes of degradation of tropical forests.

The European Union (*EU*) is one of the major commodity-consuming economies linked to deforestation because of the expansion of the agricultural frontier. The IPCC estimates that 23% of total anthropogenic greenhouse gas emissions come from agriculture, forestry and other land uses. Given the alarming conclusions published in the IPCC report, there is an urgent need to establish new rules that inhibit this change in land use, promote the reduction of deforestation and enhance the sustainable use of altered areas in the Amazon.

In this context, the European Commission proposes regulations to minimize the problem, promote the consumption of "deforestation-free" products (*European Commission, 2021*), and veto "imported deforestation" as of 2024. As a consequence of these new rules, there will be incentives to reduce deforestation and greenhouse gas emissions from tropical regions. Among the main guidelines, the regulation that establishes mandatory **due diligence rules** for operators that place six specific commodities (soybeans, beef, timber, palm oil, coffee and cocoa) on the EU market associated with deforestation and forest degradation stands out. As a result, these operators will be obliged to collect the geographical coordinates of the places where the goods were produced. This strict traceability is intended to ensure that only deforestation-free products enter the EU.

AmIT's guidelines are aligned with new global conservation scenarios. Since its conception, AmIT will aim to promote socio-economic development in the region based on strengthening the value chains of sociobiodiversity products to boost a new bioeconomy and even a new economy in the Amazon. In this way, AmIT's actions and strategies anticipate the requirements that new markets impose and seek to promote the conservation of the Amazon biome.

Assessment of the impact of AmIT

AmIT provides for the preparation of a strategic plan to delimit measures and monitoring actions for a period of 5 years. The evaluation of the objectives set by AmIT in the nine components will be carried out by an independent technical committee. Initially, some qualitative guidelines are proposed to measure the progress of AmIT's actions in five major areas:

Education and scientific production

In the first years of the implementation of AmIT, it is sought, primarily, to support teaching and research programs that contribute to the training of personnel aligned with the thematic lines within the scope of the nine proposed components. Thus, AmIT aims to contribute to the availability of postgraduate scholarships, promote funds to encourage the publication of scientific articles, encourage the leadership of Amazonian researchers in conditions of equality of gender, race and social condition.

Quality of life

During this period, AmIT will promote research and actions that improve the quality of life and social inclusion with a view to access to alternative energy sources and basic services in remote and rural areas of the Amazon. AmIT will seek to generate partnerships with institutions that monitor tropical diseases in order to reduce their incidence. In addition, it will seek to connect the people of the communities with employment opportunities in the value chains and the new businesses promoted by AmIT.

Technology, innovation and business

The promotion of the use of technology in business development is one of the main objectives of AmIT. Initially, it will seek to facilitate technical-scientific support for strengthening the value chains of the main Amazon products. The next step will be to encourage the emergence of new biobusinesses.

Outreach

AmIT will seek to increase the visibility of research products and technological solutions for society through scientific dissemination publications, access to digital information platforms, and awareness-raising activities aimed at the Amazon and international population and, even, the participation of society in the collection of data from specific research. ■

Conservation and sustainable use of forests and rivers

AmIT will support research and agroecological system implementation programs in altered areas. In addition, it will strengthen forest conservation initiatives aimed at preserving carbon stocks and guide, through partnerships, access to green markets.

9 REFERENCES

Abramovay, R., Ferreira, J., de Assis Costa, F., Ehrlich, M., Margarida, A., Euler, C., Young, C. E. F., Kaimowitz, D., Moutinho, P., Nobre, I., Rogez, H., Roxo, E., Schor, T., & Villanova, L. (2021). Chapter 30: The new bioeconomy in the Amazon: Opportunities and challenges for a healthy standing forest and flowing rivers. In C. Nobre & et al. (Eds.), *Amazon Assesment Report 2021*. United Nations Sustainable Development Solutions Network. https://www.theamazonwewant.org/spa-reports/

Addor, F. (2020). Extensão tecnológica e Tecnologia Social: reflexões em tempos de pandemia. *Revista NAU Social*, 11(21), 395–412.

Agostinho, A. A., Gomes, L. C., Santos, N. C. L., Ortega, J. C. G., & Pelicice, F. M. (2016). Fish assemblages in Neotropical reservoirs: Colonization patterns, impacts and management. *Fisheries Research*, 173(1), 26-36.

Alencar, A., Athayde, S., Bynoe, P., Duchelle, A. E., Hecht, S., Murmis, M. R., Paez, B., Painter, L., Soltani, A., & Lucas, I. L. (2021). Chapter 25: A Pan-Amazonian sustainable development vision. In C. Nobre & et al. (Eds.), *Amazon Assesment Report 2021*. United Nations Sustainable Development Solutions Network. https://www.theamazonwewant.org/spa-reports/

Alexiades, M. N. (1999). *Ethnobotany of the Ese Eja: Plants, change and health in an Amazonian society*. [PhD thesis].

Amazon Sustainable Landscape Program. (2020). *Memorias de la Conferencia Anual*. https://pubdocs.worldbank.org/en/967931608227463693/Memorias-Conferencia-Anual-ASL-2020-FINAL.pdf

Angelo, H., Calderon, R. de A., Almeida, A. N. de, Paula, M. F. de, Meira, M., Miguel, E. P., & Vasconcelos, P. G. A. (2018). Analysis of the non-timber forest products market in the Brazilian Amazon. *Australian Journal of Crop Science*, 12(10), 1640–1644. https://doi.org/10.21475/ajcs.18.12.10.pne1341

Asner, G. P., Martin, R. E., Tupayachi, R., Anderson, C. B., Sinca, F., Carranza-Jiménez, L., & Martinez, P. (2014). Amazonian functional diversity from forest canopy chemical assembly. *Proceedings of the National Academy of Science*s, 111(15), 5604–5609. https://doi.org/10.1073/pnas.1401181111

Athayde, S., Shepard, G., Cardoso, T., van der Voort, H., Zent, S., Rosero-Peña, M., Zambrano, A. A., Surui, G., & Larrea-Alcázar, D. M. (2021). Chaper 10: Critical interconnections between the cultural and biological diversity of Amazonian peoples and ecosystems. In C. Nobre & et al. (Eds.), *Amazon Assessment Report 2021* . United Nations Sustainable Development Solutions Network. https://www.theamazonwewant.org/spa-reports/

Barlow, J., Sist, P., Almeida, R., Arantes, C. C., Berenguer, E., Caron, P., Cuesta, F., Doria, C. R. C., Ferreira, J., Flecker, A., Heilpern, S., Kalamandeen, M., Lees, A. C., Nasci-Mento, N., Piponiot, C., Santos Pompeu, P., Souza, C., & Valentim, J. F. (2021). Chapter 29: Restoration priorities and benefits within landscapes and catchments and across the Amazon basin in the Amazon. In C. Nobre & et al. (Eds.), *Amazon Assesment Report 2021*. United Nations Sustainable Development Solutions Network. https://www.theamazonwewant.org/spa-reports/

Basecamp Consultoria. (2017). *Strategic Roadmap for the Brazilian Bioeconomy*.

Basso, L. S., Marani, L., Gatti, L. v., Miller, J. B., Gloor, M., Melack, J., Cassol, H. L. G., Tejada, G., Domingues, L. G., Arai, E., Sanchez, A. H., Corrêa, S. M., Anderson, L., Aragão, L. E. O. C., Correia, C. S. C., Crispim, S. P., & Neves, R. A. L. (2021). Amazon methane budget derived from multi-year airborne observations highlights regional variations in emissions. *Communications Earth & Environment*, 2(1), 246. https://doi.org/10.1038/s43247-021-00314-4

Berenguer, E., Armenteras, D., Lees, A. C., Smith, C. C., Fearnside, P., Nascimento, N., Alen-Car G, A., Almeida, C., Aragão, L., Barlow, J., Bilbao, B., Brando, P., Bynoe, P., Finer, M., Flores, B. M., Jenkins, C. N., Silva Junior, C. H. L., Souza, C., & García-Villacorta, R. (2021). Chapter 19: Drivers and ecological impacts of deforestation and forest degradation. In C. Nobre & et al. (Eds.), *Amazon Assessment Report 2021* (pp. 66055–66200). United Nations Sustainable Development Solutions Network. https://www.theamazonwewant.org/spa-reports/

Braz, R. M., Duarte, E. C., & Tauil, P. L. (2014). Algoritmo para monitoramento da incidência da malária na Amazônia brasileira, 2003 a 2010. *Revista Panamericana de Salud Pública*, 35(3), 186–192.

Brondizio, E. (2017). A Amazônia urbana é invisível /Entrevistado por Fabrício Marques. *Revista FAPESP*.

Calvino, I. (1990). *Seis propostas para o próximo milênio: lições americanas* (Primeira). Companhia das Letras.

Canalez, G. de G., Rapozo, P., Coutinho, T., & Reis, R. (2020). Espalhamento da Covid-19 no interior do Amazonas: panorama e reflexões desde o Alto Solimões, Brasil. *Mundo Amazónico*, 11(2), 111–144. https://doi.org/10.15446/ma.v11n2.88492

Carmona-Moreno, et al. (2021). *Implementing the Water-Energy-Food- Ecosystems Nexus and Achieving the Sustainable Development Goals*. UNESCO.

Carreteiro, R. (1987). *A Navegação na Amazônia*. Calderaro.

CEPAL. (2019). *Informe de avance cuatrienal sobre el progreso y los desafíos regionales de la Agenda 2030 para el Desarrollo Sostenible en América Latina y el Caribe.* https://repositorio.cepal.org/handle/11362/44551

CEPAL. (2021). *Observatorio COVID-19 en América Latina y el Caribe Impacto económico y social*. www.cepal.org/es/temas/covid-19

CGEE - Centro de Gestão e Estudos Estratégicos. (2013). Plano de Ciência, Tecnologia e Inovação para o Desenvolvimento da Amazônia Legal.

Codeço, C. T., Villela, D., Coelho, F., Bastos, L. S., Gomes, M. F. C., Cruz, O. G., Lana, R. M., Piontti, A. P., Vespignani, A., & Davis, J. T. (2020). *Estimativa de risco de espalhamento da COVID-19 no Brasil e o impacto no sistema de saúde e população por microrregião.*

CONEXSUS. (2020). *Negócios pela Tierra*. Inteligência de mercado para empreendimentos comunitários.

CNI. (2014). *Confederação Nacional da Indústria. Bioeconomia: oportunidades, obstáculos e agenda.* – Brasília: CNI, 81pp.

Cordani, U., & Juliani, C. (2019). Potencial mineral de la Amazonia: problemas y desafíos. *Revista de Estudios Brasileños*, 6(11), 91. https://doi.org/10.14201/reb201961191108

Cruz, T., & Portella, J. (2021). *A Educação na Amazônia Legal: Diagnóstico e Pontos Críticos.*

de Assis, F., Assad, E. D., Humphreys Bebbington, D., Brondizio, E. S., Fearnside, P. M., Garrett, R., Hecht, S., Heilpern, S., Mcgrath, D., Oliveira, G., Dos, H., Pereira, S., & Schmink, M. (2021). Chapter 15: Complex, diverse, and changing agribusiness and livelihood systems in the Amazon. In C. Nobre & et al. (Eds.), *Amazon Assesment Report 2021*. United Nations Sustainable Development Solutions Network. https://www.theamazonwewant.org/spa-reports/

de Freitas, N. F., & Schor, T. (2020). Bioeconomia e a Bolsa de Mercadorias da Amazônia. *Interesse Nacional*, 20–25.

Delabio, F., Cedran, D. P., Mori, L., Maria, N., & Kioranis, N. M. M. (2021). Divulgação científica e percepção pública de brasileiros(as) sobre ciência e tecnologia. *Revista Insignare Scientia*, 4(3), 273–290.

Ellwanger, J. H., Kulmann-Leal, B., Kaminski, V. L., Valverde-Villegas Jacqueline Maria, da Veiga, A. B. G., Spilki, F. R., Fearnside, P. M., Caesar, L., Giatti, L. L., Wallau, G. L., Almeida, S. E. M., Borba, M. R., da Hora, V. P., & Chies, J. A. B. (2020). Beyond diversity loss and climate change: Impacts of Amazon deforestation on infectious diseases and public health. *Anais Da Academia Brasileira de Ciências*, 92(1). https://doi.org/10.1590/0001-3765202020191375

European Commission. (2021). Proposal for a regulation on deforestation-free products. *Directorate-General for Environment*. https://ec.europa.eu/environment/publications/proposal-regulation-deforestation-free-products_en

Flores, B. M., & Levis, C. (2021). Human-food feedback in tropical forests. *Science*, 372(6547), 1146–1147. https://doi.org/10.1126/science.abh1806

Frieri, S., Bortolotto, F., Rivera, G. A., Baniwa, A., van der Hammen, C., Moutinho, P., & Arieira, J. (2021). Chapter 32: Milestones and challenges in the construction and expansion of participatory intercul-tural education in the Amazon. In C. Nobre & et al. (Eds.), *Amazon Assesment Report 2021*. United Nations Sustainable Development Solutions Network. https://www.theamazonwewant.org/spa-reports/

Gatti, L. v., Basso, L. S., Miller, J. B., Gloor, M., Gatti Domingues, L., Cassol, H. L. G., Tejada, G., Aragão, L. E. O. C., Nobre, C., Peters, W., Marani, L., Arai, E., Sanches, A. H., Corrêa, S. M., Anderson, L., von Randow, C., Correia, C. S. C., Crispim, S. P., & Neves, R. A. L. (2021). Amazonia as a carbon source linked to deforestation and climate change. *Nature,* 595(7867), 388–393. https://doi.org/10.1038/s41586-021-03629-6

Gonzalez-Perez, M. A., Mohieldin, M., Hult, G. T. M., & Velez-Ocampo, J. (2021). COVID-19, sustainable development challenges of Latin America and the Caribbean, and the potential engines for an SDGs-based recovery. *Management Research*, 19, 22–37.

Gummesson, E. (2005). Qualitative research in marketing: Road map for a wilderness of complexityand unpredictability. *European Journal of Marketing*, 39(3/4), 309-327.

Hecht, S., Abers, R., Assad, E., Humphreys Bebbington, D., Brondizio, E., Costa, F., María, A., Calisto, D., Fearnside, P., Garrett, R., Heilpern, S., Mcgrath, D., Oliveira, G., Pereira, H., Pinedo-Vazquez, M.-G., & Schmink, M. (2021). Chapter 14: Amazon in motion: Changing politics, development strategies, peoples, landscapes, and livelihoods. In C. Nobre & et al. (Eds.), *Amazon Assessment Report 2021*. Sustainable Development Solutions Network. https://www.theamazonwewant.org/spa-reports/

Hohenthal, J., & Minoia, P. (2021). Territorial and mobility justice for Indigenous youth: accessing education in Ecuadorian Amazonia. *Mobilities*. https://doi.org/10.1080/17450101.2021.1987154

Homma, A. K. O. (2012). Extrativismo vegetal ou plantio: qual a opção para a Amazônia? *Estudos Avançados*, 26(74), 167–186. https://doi.org/10.1590/S0103-40142012000100012

Homma, A.K.O. (2014). Extrativismo vegetal na Amazônia: história, ecologia, economia e domesticação. Embrapa. Brasília, DF. 418pp.

IBGE. (2019). Produção da Extração Vegetal e da Silvicultura - PEVS (No. 34).

IPCC. (2021). *Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change* (V. Masson-Delmotte, P. Zhai, A. Pirani, S. L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M. I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J. B. R. Matthews, T. K. Maycock, T. Waterfield, O. Yelekçi, R. Yu, & B. Zhou, Eds.). Cambridge University Press. In Press.

Jetz, W., Thomas, G. H., Joy, J. B., Hartmann, K., & Mooers, A. O. (2012). The global diversity of birds in space and time. *Nature*, 491(7424), 444–448. https://doi.org/10.1038/nature11631

Jimenez, É. A., Amaral, M. T., Souza, P. L. de, Ferreira Costa, M. de N., Lira, A. S., & Frédou, F. L. (2020). Value chain dynamics and the socioeconomic drivers of small-scale fisheries on the amazon coast: A case study in the state of Amapá, Brazil. *Marine Policy*, 115, 103856. https://doi.org/10.1016/j.marpol.2020.103856

Katila, P., Pierce Colfer, C. J., de Jong, W., Galloway, G., Pacheco, P., & Winkel, G. (2019). *Sustainable Development Goals: Their Impacts on Forests and People*. Cambridge University Press. https://doi.org/10.1017/9781108765015

Lacroix, V., & Zaccaï, E. (2010). Quarante ans de politique environnementale en France: évolutions, avancées, constante. Revue Française d'administration Publique, 134(2), 205. https://doi.org/10.3917/rfap.134.0205

Larrea-Alcázar, D. M., Cuvi, N., Valentim, J. F., Diaz, L., Vidal, S., & Palacio, G. (2021). Chapter 11: Economic drivers in the Amazon from the 19 th century to the 1970s. In C. Nobre & et al. (Eds.), *Amazon Assessment Report 2021*. United Nations Sustainable Development Solutions Network. https://www.theamazonwewant.org/spa-reports/

Lovejoy, T. E., & Nobre, C. (2018). Amazon tipping point. *Science Advances*, 4, eaat2340.

Mapbiomas. (2020). *Mapbiomas Amazonia*. https://mapbiomas.org/

McGrath, D. G., Castello, L., Brabo, M., Nepstad, D., da Gama, S., Forsberg, B., Mendoza, E., Ribeiro, A., Almeida, O. T., Bentes, A. J., & Chan, C. (2020). Can fish drive development of the Amazon bioeconomy? Policy Brief. *Earth Innovation Institute*.

McKay, B. M. (2017). Agrarian Extractivism in Bolivia. *World Development*, 97, 199–211. https://doi.org/10.1016/j.worlddev.2017.04.007

Mello, L.E.A.M., Sepúlveda, E.S. (2017). Interação academia--indústria. Relato da experiência da Vale. *Estudos Avançados*, 31(90), 89-101.

Meyerson, B. (2015). Top 10 emerging technologies of 2015. *World Economic Forum*. https://www.weforum.org/agenda/2015/03/top-10-emerging-technologies-of-2015-2

Nakata, M., Nakata, V., Keech, S., & Bolt, R. (2012). Decolonial goals and pedagogies for Indigenous studies. Decolonization: *Indigeneity, Education & Society,* 1(1).

NASEM - National Academies of Sciences, Engineering and Medicine. (2020). Safeguarding the Bioeconomy. Washington, D.C. *National Academies Press.*

Nobre, I., & Nobre, C. (2019). The Amazonia Third Way Initiative: The Role of Technology to Unveil the Potential of a Novel Tropical Biodiversity-Based Economy. In L. C. Loures (Ed.), Land Use - Assessing the Past, Envisioning the Future. *IntechOpen*. https://doi.org/10.5772/intechopen.80413

Opas, M., Felipe Torres, L., Milanez, F., & Shepard, G. Jr. (2018). Resistance beyond the Frontier: Concepts and Policies for the Protection of Isolated Indigenous Peoples of the Amazon. *Tipití: Journal of the Society for the Anthropology of Lowland South America*, 16(1), 1–4. https://digitalcommons.trinity.edu/tipiti/vol16/iss1/1

PAS. (2008). Plano Amazônia Sustentável. Diretrizes para o desenvolvimento sustentável da Amazônia brasileira. Presidência da República. *Ministério do Meio Ambiente*.

Pecharroman, L. C. (2018). Rights of nature: Rivers that can stand in court. *In Resources* (Vol. 7, Issue 1). MDPI AG. https://doi.org/10.3390/resources7010013

Pennano, G. (1988). La economía del caucho. *Centro de Estudios Teológicos de la Amazonía Iquitos*, Perú.

Pivetta, M. (2019). A floresta da chuva. *Revista Fapesp* 285.

Pivetta, M. (2021). Clima no antropoceno. *Revista Fapesp* 307.

Platiau, A. F. B. & Varella, M. D. (2004). *Diversidade Biológica e Conhecimentos Tradicionais*. Ed. Del Rey. Belo Horizonte.

Poorter, L., Craven, D., Jakovac, C. C., van der Sande, M. T., Amissah, L., Bongers, F., Chazdon, R. L., Farrior, C. E., Kambach, S., Meave, J. A., Muñoz, R., Norden, N., Rüger, N., van Breugel, M., Almeyda Zambrano, A. M., Amani, B., Andrade, J. L., Brancalion, P. H. S., Broadbent, E. N., … Hérault, B. (2021). Multidimensional tropical forest recovery. *Science*, 374(6573), 1370–1376. https://doi.org/10.1126/science.abh3629

Pusca, D., & Northwood, D. O. (2018). Design thinking and its application to problem solving. *Global Journal of Engineering Education,* 20(1), 48–53. https://www.researchgate.net/publication/323277797

Queiroz, L.A. & Mafra, R. Z. (2017). A comercialização dos produtos naturais da biodiversidade amazônica: características da oferta no comércio varejista em Manaus. In: Mafra, R. Z.; Medeiros, R. L. (Organizadores). Estudos da Bioindústria Amazonense: Sustentabilidade, Mercado e Tecnologia. *Universidade Federal do Amazonas – Manaus*. 93-112.

Reis, A., Magne, K., Massot, S., Tallini, L. R., Scopel, M., Bastida, J., Ratet, P., & Zuanazzi, J. A. S. (2019). Amaryllidaceae alkaloids: identification and partial characterization of montanine production in Rhodophiala bifida plant. *Scientific Reports*, 9(1), 8471. https://doi.org/10.1038/s41598-019-44746-7

Riisgaard, L., Bolwig, S., Ponte, S., du Toit, A., Halberg, N., & Matose, F. (2010). Integrating Poverty and Environmental Concerns into Value-Chain Analysis: A Strategic Framework and Practical Guide. *Development Policy Review,* 28(2), 195–216. https://doi.org/10.1111/j.1467-7679.2010.00481.x

Silva, T. M. da, Jardim, F. C. da S., Silva, M. D. S., & Shanley, P. (2010). O mercado de amêndoas de Dipteryx odorada (cumaru) no estado do Para. *Floresta*, 40(3). https://doi.org/10.5380/rf.v40i3.18922

Silva, K. B., & Mafra, R. Z. (2017). A bioeconomia no Amazonas: Análise dos entraves ao desenvolvimento da Bioindústria à luz da Teoria Institucionalista. In: Mafra, R. Z., Medeiros, R. L. (Organizadores). Estudos da Bioindústria Amazonense: Sustentabilidade, Mercado e Tecnologia. *Universidade Federal do Amazonas – Manaus*. p53-72.

ter Steege, H., Prado, P. I., Lima, R. A. F. de, Pos, E., de Souza Coelho, L., de Andrade Lima Filho, D., Salomão, R. P., Amaral, I. L., de Almeida Matos, F. D., Castilho, C. v., Phillips, O. L., Guevara, J. E., de Jesus Veiga Carim, M., Cárdenas López, D., Magnusson, W. E., Wittmann, F., Martins, M. P., Sabatier, D., Irume, M. V., … Pickavance, G. (2020). Biased-corrected richness estimates for the Amazonian tree flora. *Scientific Reports*, 10(1), 10130. https://doi.org/10.1038/s41598-020-66686-3

Tanasescu, M. (2017). Responsibility and the Ethics of Ecological Restoration. *Environmental Philosophy*, 14(2), 255-274.

Tourinho, E., de Oliveira, S., Ribas, C., Lopes, A., & Val, A. (2021). Qual o impacto dos cortes em C&T e Educação para o Brasil e, em particular, para a Amazônia? *Mesa Redonda Da Academia Brasileira de Ciência – ABC*. https://brasilamazoniaagora.com.br/2021/qual-o-impacto-dos-cortes-ct-e-educacao-para-amazonia-mesa-redonda/

UEA. (2020). Bioeconomia: UEA lança a 1a Escola de Negócios da Floresta Amazônica. *Informe Manaus*. https://informemanaus.com/2020/bioeconomia-uea-lanca-a-1a-escola-de-negocios-da-floresta-amazonica/

UNESCO. (2015). Relatório de Ciência da UNESCO: Rumo a 2030. Visão Geral e Cenário Brasileiro.

Val, A. L. (2006). Formação e fixação de recursos humanos - Ações essenciais para a Amazônia. *Ciência e Cultura*, 58(3), 41–44.

Val, A. L., & de Almeida, J. (2005). Um novo momento para a pesquisa e a pós-graduação na Amazônia.

Verschuuren, B., Subramanian, S. M., & Hiemstra, W. (2014). Community Well-being in Biocultural Landscapes. *Practical Action Publishing*. https://doi.org/10.3362/9781780448374

Viana, D. (2021). Riqueza que vem da vida. *FAPESP*, 306.

Villa Nova, L. (2020). Promoção de bioeconomia da sociobiodiversidade amazônica: o caso da Natura Cosméticos S.A com comunidades agroextrativistas na região do Baixo Tocantins no Pará. *Fundação Getúlio Vargas.*

Wali, A., Alvira, D., Tallman, P. S., Ravikumar, A., & Macedo, M. O. (2017). A new approach to conservation: using community empowerment for sustainable well-being. *Ecology and Society*, 22(4), art6. https://doi.org/10.5751/ES-09598-220406

Willerding, A. L., da Silva, L. R., da Silva, R. P., de Assis, G. M. O., & de Paula, E. V. C. M. (2020). Estratégias para o desenvolvimento da bioeconomia no estado do Amazonas. *Estudos Avancados,* 34(98), 143–165. https://doi.org/10.1590/S0103-4014.2020.3498.010

Woodward, D. (2015). Incrementum ad Absurdum: Global Growth, Inequality and Poverty Eradication in a Carbon--Constrained World. *World Economic Review*, 43–62.

10 ATTACHMENTS

Attachment 1. Potential institutions to form the AmIT network.

Level	Institution	Country	Website	Potential interaction With the AmIT network
Regional – Pan-Amazon	IPAAM-AM	Brazil	www.ipaam.am.gov.br	Authorizations and support
	FAS	Brazil	www.fas-amazonas.org	Collection and regional access
	Comando Militar da Amazônia	Brazil	www.cma.eb.mil.br	Collection and regional access
	IPAM Amazônia	Brazil	www.ipam.org.br	Collection and regional access
	IMAZON	Brazil	www.imazon.org.br	Collection and regional access
	COIAB - Br	Brazil	www.coiab.org.br	Cooperation
	Instituto Mamirauá	Brazil	www.mamiraua.org.br	Research
	IEC – Evandro Chagas	Brazil	www.iec.gov.br	Research
	FIOCRUZ - AM	Brazil	www.amazonia.fiocruz.br	Research
	CBA	Brazil	www.suframa.gov.br/publicacoes/site_cba/index.htm	Research and bioengineering
	INPA	Brazil	www.inpa.gov.br	Research and training
	MPEG	Brazil	www.museu-goeldi.br	Research and training
	UFAM	Brazil	www.ufam.edu.br	Research and training
	UFPA	Brazil	www.portal.ufpa.br	Research and training
	UFRA	Brazil	www.novo.ufra.edu.br	Research and training
	UFOP	Brazil	www.ufop.br	Research and training
	UFMA	Brazil	www.portalpadrao.ufma.br	Research and training
	UFTO	Brazil	www.uft.edu.br	Research and training
	UFAC	Brazil	www.ufac.br	Research and training
	UFRR	Brazil	www.ufrr.br	Research and training
	UNIR	Brazil	www.unir.br	Research and training
	UFMT	Brazil	www.ufmt.br	Research and training
	UNIFAP	Brazil	www.unifap.br	Research and training
	UEA	Brazil	www.uea.edu.br	Research and training
	UEPA	Brazil	www.uepa.br	Research and training
	UNEMAT	Brazil	www.unemat.br	Research and training
	UEAP	Brazil	www.ueap.edu.br	Research and training
	UERR	Brazil	www.uerr.edu.br	Research and training
	UNITINS	Brazil	www.unitins.br	Research and training
	HMT-HVD	Brazil	www.fmt.am.gov.br	Research and training
	AIDESEP	Peru	www.aidesep.org.pe	Cooperation
	IIAP	Peru	www.iiap.org.pe/web/	Research and extension
Regional – Pan-Amazon	Univ. Nacional de la Amazonia Peruana - UNAP	Peru	www.unapiquitos.edu.pe	Research and training
	Univ. Nacional Autonoma de Alto Amazonas - UNAAA	Peru	www.unaaa.edu.pe	Research and training
	Asociación Amazónicos por la Amazonía - AMPA	Peru	www.ampaperu.info	Research and training
	Instituto del Bien Común - IBC	Peru	www.ibcperu.org	Research
	Asociación para la Investigación y Desarrollo Integral - AIDER	Peru	www.aider.com.pe	Research and extension
	Instituto Nacional de Innovación Agraria - INIA	Peru	www.inia.gob.pe	Research and extension
	Univ. Nacional Intercultural de la Amazonía - UNIA	Peru	www.unia.edu.pe	Research and training
	Univ. Nacional Amazónica de Madre de Dios - UNAMAD	Peru	www.unamad.edu.pe	Research and training
	Univ. Nacional de Ucayali - UNU	Peru	www.unu.edu.pe	Research and training
	Univ. Nacional Agraria de la Selva - UNAS	Peru	www.unas.edu.pe	Research and training
	Centro para el Desarrollo del Indígena Amazónico - CEDIA	Peru	www.cedia.org.pe	Research and extension

Level	Institution	Country	Website	Potential interaction With the AmIT network
Regional – Pan-Amazon	Centro de Innovación Científica Amazónica - CINCIA	Peru	https://cincia.wfu.edu/	Research and extension
	Univ. Nacional Toribio Rodríguez de Mendoza de Amazonas - UNTRM	Peru	www.untrm.edu.pe	Research and training
	Univ. Mayor de San Andrés	Bolivia	www.umsa.bo	Research and training
	Univ. Mayor San Simon	Bolivia	www.umss.bo	Research and training
	SINCHI	Colombia	www.sinchi.org.co	Research
	Univ. Regional Amazónica Ikiam	Colombia	www.ikiam.edu.ec/	Research and training
	Univ. Nacional de Colombia	Colombia	www.unal.edu.co	Research and training
	Pontificia Univ. Javeriana	Colombia	www.javeriana.edu.co	Research and training
	Univ. Estatal Amazónica	Ecuador	www.uea.edu.ec	Research and training
	Univ. Regional Amazónica	Ecuador	www.ikiam.edu.ec	Research and training
	CONFENIAE	Ecuador	www.confeniae.net	Cooperation
	Univ. de Los Andes	Venezuela	www.ula.ve	Research and training
	IVIC	Venezuela	www.ivic.gob.ve	Research
	Université de Guyane	French Guiana	www.univ-guyane.fr	Research and training
	University of Guyana	Guiana	www.uog.edu.gy	Research and training
	Univ. Anton de Kom	Suriname	www.adekus.edu	Research and training
	Corporación para el Desarollo Sostenible del Sur de la Amazonia - CORPOAMAZONIA	Colombia	www.corpoamazonia.gov.co/	Cooperation
Inter-Regional	SDSN-Amazônia		www.sdsn-amazonia.org	Extension
	OTCA		www.otca-oficial.info	Cooperation
	COICA		https://coica.org.ec/	Cooperation
International	Massachusetts Institute of Technology (MIT)	United States	https://www.mit.edu	Research and training
	Stanford University	United States	https://www.stanford.edu	Research and training

Level	Institution	Country	Website	Potential interaction With the AmIT network
International	University of Cambridge	United Kingdom	https://www.cam.ac.uk	Research and training
	ETH Zurich - Swiss Federal Institute of Technology	Switzerland	https://ethz.ch	Research and training
	Nanyang Technological University Singapore (NTU)	Singapore	https://www.ntu.edu.sg	Research and training
	Imperial College London	United Kingdom	https://www.imperial.ac.uk	Research and training
	National University of Singapore (NUS)	Singapore	https://www.nus.edu.sg	Research and training
	The University of Tokyo	Japan	https://www.u-tokyo.ac.jp	Research and training
	University of Oxford	United Kingdom	https://www.ox.ac.uk	Research and training
	Tsinghua University	China	https://www.tsinghua.edu.cn	Research and training
	University of California, Berkeley (UCB)	United States	https://www.berkeley.edu	Research and training
	EPFL - Ecole Polytechnique Federale de Lausanne	Switzerland	https://www.epfl.ch	Research and training
	Harvard University	United States	https://www.harvard.edu	Research and training
	Tokyo Institute of Technology	Japan	https://www.titech.ac.jp	Research and training
	KAIST - Korea Advanced Institute of Science & Technology	South Korea	https://www.kaist.ac.kr	Research and training
	Seoul National University	South Korea	https://en.snu.ac.kr	Research and training
	Politecnico di Milano	Italia	https://www.polimi.it	Research and training
	The Hong Kong University of Science and Technology	Hong Kong	https://hkust.edu.hk	Research and training
	National Taiwan University (NTU)	Taiwan	https://www.ntu.edu.tw	Research and training
	Peking University	China	https://english.pku.edu.cn	Research and training
	Kyoto University	Japan	https://www.kyoto-u.ac.jp	Research and training
	Delft University of Technology	Netherlands	https://www.tudelft.nl	Research and training
	Universiti Malaya (UM)	Malaysia	https://www.um.edu.my	Research and training
	Georgia Institute of Technology	United States	https://www.gatech.edu	Research and training
	Technical University of Munich	Germany	https://www.tum.de	Research and training

Attachment 2. Potential institutions and funds for the implementation of AmIT.

N°	Institution	Website
1	Deutsche Agentur für Technische Zusammenarbeit - GTZ	*htpp://www.gtz.de*
2	Australian Agency for International Development - AUSAID	*htpp://www.ausaid.gov.au*
3	Canadian Agency for International Development - ACDI	*htpp://www.acdi-cida.gc.ca*
4	International Cooperation Agency of Finland - CIMO	*htpp://www.cimo.fi*
5	Agencia de Cooperación Internacional de Chile - AGCI	*htpp://www.agci.cl*
6	Danish International Development Agency-DANIDA	*htpp://www.um.dk*
7	United States Agency for International Development - USAID	*htpp://www.usaid.gov*
8	Agencia Española de Cooperación Internacional - AECI	*htpp://www.aeci.es*
9	Agence Française de Développement-AFD - France	*htpp://www.afd.fr*
10	Japanese Agency for International Cooperation - JICA	*htpp://www.jica.go.jp*
11	Norwegian Agency for Development Cooperation - NORAD	*htpp://www.norad.no*
12	Presidential Agency for Social Action and International Cooperation - ACCI	*htpp://www.acci.gov.co*
13	Swedish International Cooperation Agency - SIDA	*htpp://www.sida.se*
14	Columbus Association - Cooperation between Europe and Latin America	*htpp://www.columbus-web.com*
15	Academic Cooperation Association - ACA	*htpp://www.aca.secretariat.be*
16	Asociación de Universidades – Grupo Montevidéu - Uruguai	*http://www.grupomontevideo.edu.uy*
17	Association of Universities – Santander Group	*htpp://www.sgroup.be*
18	Association of African Universities - AAU	*htpp://www.aau.org*
19	Association of Arab Universities - AARU	*htpp://www.aaru.edu.jo*
20	Asociación de Universidades de América Latina y el Caribe para la Integración	*htpp://www.aualcpi.org*
21	Association of Universities of Asia and the Pacific - AUAP	*htpp://sut2.sut.ac.th/auap*
22	Association of European Universities - EUA	*htpp://www.unige.ch/eua*
23	Association of European Universities - Coimbra Group	*htpp://www.coimbra-group.be*
24	Asociación de Universidades Jesuitas de América Latina - AUSJAL	*htpp://www.ausjal.org*
25	European Association of International Education - European Union	*htpp://www. Eaie.nl*
26	Association Internationale des Recteurs d'Université - IAUP	*htpp://www.cpu.fr*
27	International Association of Universities	*htpp://www.unesco.org/iau*
28	Asociación Universitaria Iberoamericana de Postgrado - AUIP	*htpp://www.usal.es/auip*
29	Asian Development Bank - ADB	*htpp://www.asiandevbank.org*
30	Banco Centroamericano de Integración Económica - BCIE	*http://www.bcie.hn*
31	Inter-American Development Bank-IDB	*htpp://www.iadb.org*
32	World Bank	*htpp://www.worldbank.org*
33	International Development Research Center - IDRC	*htpp://www.idrc.ca*
34	European Center for Higher Education - CEPES/UNESCO	*htpp://www.cepes.ro*
35	Center for Research and Innovation in Education - CERI/OECD	*htpp://www.oecd.org/cer*
36	Centro Universitario de Desarrollo - CINDA	*htpp://www.cinda.cl*
37	Fulbright Commission	*htpp://www.fulbright.org.br*
38	OECD Development Aid Committee	*htpp://www.oecd.org/dac*
39	United Nations Conference on Trade and Development - UNCTAD	*htpp://www.unctad.org*
40	British Council	*htpp://www.britcoun.org*
41	Council of Europe	*htpp://www.coe.int*
42	Conselho de Reitores para a Integração da Sub-região Centro Oeste da América do Sul - CRISCOS	*htpp://www.criscos.org*
43	Conselho Nacional de Desenvolvimento Científico e Tecnológico - CNPq	*www.cnpq.br*
44	Conselho Superior Universitário Centroamericano - CSUCA	*http://www.csuca.org*
45	Conselho Universitário Iberoamericano - CUIB	*htpp://www.cuib.org*
46	Conselho Universitário Interamericano para o Desenvolvimento Econômico e Social - CUIDES	*htpp://www.cuides.org*
47	Convenio Andrés Bello - América Latina y España	*htpp://www.cab.int.co*
48	Cooperación Andina de Fomento - CAF	*htpp://www.caf.com*

N°	Institution	Website
49	Coordenação de Aperfeiçoamento de Pessoal de Nível Superior - CAPES	*www.gov.br/capes/pt-br*
50	Direzione Generale per la Cooperazione e lo Sviluppo dell'Italia - DGCS	*htpp://www.ice.it/mae/xvi/homepage.htm*
51	Directories of Development Organizations	*htpp://www.devidir.org*
52	Financiadora de Estudos e Projetos - FINEP	*www.finep.gov.br*
53	Alfred P. Sloan Foundation	*htpp://www.sloan.org*
54	Alfred von Humboldt Stiftung	*htpp://www.avh.de*
55	Fundação Amazônia Paraense de Amparo à Pesquisa - FAPESPA	*www.fapespa.pa.gov.br*
56	Amoco Foundation	*htpp://www.bpamoco.com*
57	Andrew W. Mellon Foundation	*htpp://www.mellon.org*
58	Arnold and Mabel Beckmman Foundation	*htpp://www.beckman-foundation.com*
59	Conrad Adenauer Stiftung	*htpp://www.kas.de*
60	Fundação de Amparo à Pesquisa do Amapá - FAPEAP	*www.fapeap.portal.ap.gov.br*
61	Fundação de Amparo a Pesquisa do Estado de Mato Grosso - FAPEMAT	*www.fapemat.mt.gov.br*
62	Fundação de Amparo à Pesquisa do Estado de São Paulo - FAPESP	*www.fapesp.br*
63	Fundação de Amparo á Pesquisa do Estado do Acre - FAPAC	*www.fapapc.acre.gov.br*
64	Fundação de Amparo à Pesquisa do Estado do Amazonas - FAPEAM	*www.fapeam.am.gov.br*
65	Fundação de Amparo à Pesquisa do Estado do Tocantins - FAPT	*www.fapt.to.gov.br*
66	Fundação de Amparo à Pesquisa e ao Desenvolvimento Científico e Tecnológico do Maranhão - APEMA	*www.fapema.br*
67	Ford Foundation	*htpp://www.fordfound.org*
68	Friedich Ebert Stiftung	*htpp://www.fes.de*
69	Friedrich Naumann Stiftung	*http://www.fnst.de*
70	Fritz Thyssen Stiftung	*htpp://www.fritz-thyssen-stiftung.de*
71	Fondazione Giovanni Agnelli	*htpp://www.fga.it*
72	International Foundation for Science - ISF	*htpp://www.ifs.se*

N°	Institution	Website
73	Kresge Foundation	*htpp://www.kresge.org*
74	Bill and Melinda Gates Foundation	*htpp://www.gastesfoundations.org*
75	John Simon Guggenheim Memorial Foundation	*htpp://www.gf.org*
76	National Science Foundation of Switzerland - SNSF	*https://www.snf.ch/en*
77	Fundación para la Educación Superior Internacional Ac	*htpp://www.fesi.org.mx*
78	Rockefeller Foundation	*htpp://www.rockfound.org*
79	Fundação Rondônia - FAPERO	*www.rondonia.ro.gov.br/fapero/*
80	Soros Foundation	*htpp://www.soros.org*
81	Tinker Foundation	*htpp://www.fdncenter.org/grantmaker/tinker*
82	W. K. Kellog Foundation	*htpp://www.wkkf.org*
83	European Development Fund	*htpp://www.europa.eu.int/comm*
84	Newton Fund	*https://www.britishcouncil.org.br*
85	Institut de Recherche pour le Développement	*htpp://www.ird.fr*
86	Instituto Internacional de Educación Superior en América Latina y el Caribe - IESALC	*htpp://www.iesalk.unesco.org.ve*
87	Manchester Institute of Innovation Research	*https://www.alliancembs.manchester.ac.uk*
88	United Nations	*htpp://www.un.org*
89	UNESCO Regional Science and Technology Workshop for Latin America	*htpp://www.unesco.org.uy*
90	United Nations Food and Agriculture Organization - FAO	*htpp://www.fao.org*
91	United Nations Industrial Development Organization - ONUDI	*htpp://www.unido.org*
92	Organization of American States	*http://www.oas.org*
93	Organización de los Estados Iberoamericanos para la Educación, La Ciencia y la Cultura - OEI	*htpp://www.oei.es*
94	Netherlands Organisation for International Cooperation in Higher Education	*htpp://www.nuffic.nl*
95	International Labour Organization	*htpp://www.ilo.org*
96	Organization for Economic Cooperation and Development - OCDE	*htpp://www.oecd.org*

N°	Institution	Website
97	Inter-American University Organization - OIU	*htpp://www.oiu.iohe.qc.ca*
98	Portal Proteus	*htpp://www.ploteus.net*
99	Portal Universia	*htpp://www.universia.net*
100	Alban Program of the European Union	*htpp://www.programalban.org*
101	Alpha Program of the European Union	*htpp://www.europa.eu.*
102	United Nations Development Program - PNUD	*htpp://www.undp.org*
103	Programa Iberoamericano de Ciencia y Tecnología para el Desarrollo - CYTEC	*htpp://www.cytec.org*
104	European Union Research and Development Marcop Program	*htpp://www.cordis.lu/fp6*
105	Programa PIMA de la Organización de Estados Iberoamericanos	*htpp://www.oei.es*
106	Higher Education Cooperation Programs of the European Union	*htpp://www.europa.eu.int/comm/education*
107	European Network of Quality Assurance in Higher Education	*htpp://www.enqa.net*
108	Secretaria de Cooperação Ibero-americana	*htpp://www.secib.org*
109	German Academic Exchange Service	*htpp://www.daad.org*
110	EuropeAid - European Union Cooperation Service	*http://ec.europa.eu/comm/europeaid*
111	Third World Academy of Sciences - TWAS	*htpp://www.twas.org/researchgrants.pdf*
112	UNESCO	*htpp://www.unesco.org*
113	Unión de Universidades de América Latina y el Caribe - UDUAL	*htpp://www.unam.mx/udual*
114	European Union	*http://europa.eu.int*
115	Universidade das Nações Unidas - UNU	*htpp://www.unu.edu*
116	Universidades Grupo Tordesilhas	*htpp://www.grupotordesillas.org*
117	Fondo de Investigación y Desarrollo para la Competitividad - FIDECOM	*www.proinnovate.gob.pe*
118	Fondo Nacional de Desarrollo Científico, Tecnológico y de Innovación Tecnológica - FONDECYT	*www.fondecyt.gob.pe*
119	F. Hoffmann-La Roche	*www.roche.com/sustainability/philanthropy.htm*
120	IBM Corporation	*www.ibm.org/*
121	Novartis International	*www.novartis.com*
122	Merck & Co., Inc.	*www.merck.com*
123	AstraZeneca plc	*www.astrazeneca.com*
124	Pfizer Inc	*www.pfizer.com.pe*
125	Ford Foundation	*www.fordfoundation.org*
126	William and Flora Hewlett Foundation	*www.hewlett.org*
127	Fundação John D. and Catherine T. MacArthur	*www.macfound.org/*

Credits

AUTHORS

Adalberto Luis Val (INPA)
Estêvão Vicente Monteiro de Paula (UEA)
André Luis Willerding (INPA)
Lucas Ribeiro Prado
Lourdes Falen Horna

REVIEWERS

Carlos Afonso Nobre (USP)
Maritta Koch-Weser (Earth3000)

COLLABORATORS

IEA
Guilherme Ary Plonski
Rafael Borsanelli
Jose Pedro de Oliveira Costa
Tizuko Sakamoto
Roque Celeste Passos

FUSP
Fernanda Cristina Pereira Santos
Jaqueline Lisa Dias Porto
Leonardo de Sales Dias

Arapyaú
Renata Piazzon
Rafaela Bergamo
Érica Dias
João Santoro
Débora Passos

MIT
Bradley Olsen
John Fernández
Rosabelli Coelho-Keyssar
Marco de Paula

SDSN
Carolina Ramírez Méndez

TRANSLATION

Matthew Miller
Lourdes Falen Horna

ART AND DESIGN DIRECTION

Fabio Issao

LAYOUT AND ILLUSTRATION PROJECT

Caco Neves (autoestudio)
Bruno Oliveira (autoestudio)

PRINT

Imagem Digital

Photography: Source @unsplash


AMiT
Amazon Institute of
Technology