

# THE NEED OF A NOVEL SUSTAINABLE DEVELOPMENT PARADIGM FOR THE AMAZON<sup>1</sup>

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*We abuse land because we regard it as a commodity belonging to us. When we see land as a community to which we belong, we may begin to use it with love and respect.*

Aldo Leopold

## 1 INTRODUCTION

The challenges to achieving sustainable development in the Amazon can be broadly categorized in three categories (Nobre and Nobre, 2019), similarly to a conceptual framework laid out for planetary health (Whitmee *et al.*, 2015):

- conceptual failures (imagination challenges), such as the vision of the Amazon as only a source of agricultural and mineral commodities and energy and the lack of imagination to create alternative, less socially and environmentally damaging development pathways based on the rich biodiversity;
- knowledge failures (research and information challenges), such as negligible amount of research funding to Amazonian institutions and focus of research and monitoring systems on land use transformations and a negligible investment to unveil the hidden economic and societal value of biological and biomimetic assets; and
- implementation failures (governance and policy challenges and entrepreneurial capacity failures), such as the failure of Amazonian countries' governments to recognize the risks of current and past development policies and the inefficient implementation of a diversified economy by public and private actors and even the failure to share more equitably the benefits of the current resource-intensive economy.

The discourse on "Amazon sustainability" has been allowed to proceed as a sign of the times and to be aligned with global trends starting with the 1992 Earth Summit in Rio and to transmit an international aura of adherence, but the concrete development policies for the

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Amazon never in fact deviated from the one devised by military governments (*e.g.*, Brazil, Peru, Bolivia) in the 1970's out of geopolitical concerns: livestock and agricultural occupation to ensure land tenure as necessary for sovereignty and exploitation of minerals, hydropower and fossil fuels as drivers of economic development for the country as a whole seeing the Amazon as provider of raw materials only.

The intense and swift expansion of the Brazilian agriculture frontier in the Amazon resulted not only in the growth of the country's gross domestic product (GDP) since the 1960s, but also in the rates of tree felling and greenhouse gas emissions — a consequence of conversion of forest landscapes into pasture for cattle raising and for grain crops. Some numbers illustrate this human-orchestrated metamorphosis. Since 1997, more than 20 billion trees have been cut in the world's largest rainforest. In 2019, over 70% of the 10,000 km<sup>2</sup> of Amazon deforestation was transformed into new pastures. Currently, beef and dairy farming and production, including clearing forests to create new grasslands, account for 45% of gross Brazilian GHG emissions (SEEG, 2020).

The natural resource intensive mode of development in the Tropics is the dominant mode of development and receives generous governments subsidies and private sector investments for its continued advancement. Investments in conservation, forest restoration and a sustainable economy in the global Tropics of about \$ 20 billion annually is less than 3% of total investments. The bulk of investments (around \$ 770 billion annually) goes to the expansion of commodities frontier of cattle, grains, oil palm (Haupt *et al.*, 2017) and also to road, energy and mining infrastructure, which are also directly (Sonter *et al.*, 2017) or indirectly key drivers of deforestation, primarily the opening of roads. Infrastructure projects such as hydropower dam construction are also linked to health impacts such as spread of malaria (Angelo *et al.*, 2017). One more detrimental effect of such path is the increasing rural violence in the Amazon. Brazil has the highest number of assassinated rural and environmental leaders since 2015, with more than 140 killings annually, mostly in the Amazon (Global Witness, 2017).

The main public policies responsible for the most of the sharp reduction of over 70% in deforestation from 2005 to 2014 in Brazilian Amazon (Assunção, Gandour and Rocha, 2015; Moutinho, Guerra and Azevedo-Ramos, 2016) seem to have already reached their limit, so much so that deforestation has been growing since then, even throughout a period of historic economic recession and stagnation in Brazil, demonstrating once again the decoupling of deforestation with economic growth, neither when GDP grows nor when GDP declines. The underlying reasons for continued land cover change are more complex than simply responding to global markets demands of beef and grains.

For some time, part of the agribusiness exporting sector has voiced an agricultural development policy idealized for the Amazon to be associated with the reduction of deforestation through what has been termed “sustainable intensification” in the forest biome of the Amazon and in the Cerrado tropical savannas. That is, increases in productivity of grain agriculture and especially of livestock farming would be the engine to meet rising world demand for grains and meat without the need for further deforestation. That would naturally reduce the pressure for new agricultural areas. Embrapa and the applied agricultural research sector of Brazilian universities and elsewhere have in fact been developing a range of high impact technologies to enable sustainable intensification, which in principle increases the profitability of rural activity and reduces but does not eliminate the environmental impact

and degradation especially in the context of exponential growth of demand from emerging middle classes in China and India.

But only the intensification of livestock and grain production is no guarantee that the deforestation vector will disappear. The dynamics of tree felling in the Amazon is based to a large extent on the invasion of public lands and protected areas for illegal logging, culminating in the clear-cutting of the forest and its transformation into pastures to feed the cattle herd. Often, degraded pastures are abandoned giving rise to new deforestation with the same goal, a vicious cycle with a highly negative impact.

The structural failure of the sustainable intensification model is that increasing the profitability of the agricultural sector through increased productivity inevitably attracts more capital to the activity and the pressure forces for the expansion of the agriculture frontier continue to exist, as is the case with the continued expansion of the commodity frontier in the Amazon and Cerrado. The classical Jevons Paradox may be already in operation in Tropical South America. This model is clearer when one looks at the rapid growth of the urban middle classes particularly in Asia that considerably increases the demand for these commodities, accelerating the pressure for the expansion of the commodity frontier in order not to lose market opportunities, although, in principle, the increase of the demand could be met by augmented productivity. In other words, the seeds of an expansionist livestock and grain crop sectors are still present in the Brazilian economy, supported by the economic and political weight that the sector represents, in the current phase when Brazilian economy goes back to being mostly an economy of primary commodities.

Unfortunately, we may not have a long window of time to change course with respect sustainable pathways for the Amazon. Tipping points not to be transgressed for forest-climate stability are in the horizon (Nobre and Borma, 2009; Lovejoy and Nobre, 2018). The Amazon forest is being increasingly affected by many drivers of change, namely climate change arising from both global warming — primarily hydrological changes — and regional deforestation and increased frequency of forest fires. Those drivers pose a great risk of a tipping point being transgressed that would lead to a large-scale, irreversible *savannization* of central, eastern and southern Amazon. Climate model calculations indicate that we should not exceed 20-25% (Nobre *et al.*, 2016) of total deforested area to be on the safe operating space for these drivers of change. Currently, total deforestation of tropical forests in the Amazon basin is around 15-16% (RAISG, 2015), reaching 20% in the Brazilian Amazon (INPE, 2018). Observations show a lengthening of the dry season in parts of the Amazon (Fu *et al.*, 2013) and increased mortality of many plant species (Esquivel-Muelbert *et al.*, 2018), perhaps precursory signs of a tipping point. The sense of urgency to avert a systemic risk to the Amazon forests must be kept in mind in the search for solutions.

## 2 THE AMAZON THIRD WAY

For the last two decades, the Amazon development debate has been torn between attempts to reconcile two rather opposing views: on one hand, a vision of setting aside large tracts of the Amazon forests for conservation purposes (referred hereafter to as The First Way) and, on the other hand, seeking a “sustainable” resource-intensive development, mostly through agriculture/livestock, energy and mining (referred hereafter to as The Second Way). However, reality is showing that a “convergent reconciliation” is not happening at all for the obvious reason that high input agriculture/livestock drives a rapid expansion of the commodity frontier, especially for beef production, and industrial-scale mining requires infrastructure

such as energy and roads and that, in turn, drives many people into the Amazon and further deforestation for agriculture/livestock purposes.

The decrease of Amazon deforestation from 2005 to 2014 (about 75% decline) and with agricultural production that doubled during that period opens a window of opportunity to think of a novel sustainable development paradigm: The Amazon Third Way initiative (Nobre and Nobre, 2018).

It is becoming crystal clear that trying to reconcile resource intensive development with conservation is not leading to lasting and permanent solutions. Deforestation rates are still very high and do not show a tendency to go down near zero and rural violence is on the rise. Social inequalities in the Amazon remain high and are not improving at a fast pace at least to bring social indicators to the national averages of the Amazonian countries. Imposing strict conservation to protect large swathes of the forest has had clear successes over the last decades in the Amazon — about 50% of the Amazon forest is under some kind of protection. However, that in itself does not guarantee protection forever for tropical forests and eventually may affect the livelihoods of local population as is the case documented for Madagascar (Poudyal *et al.*, 2018) who may bear a high cost for forest conservation.

Forests in the Amazon are the result of millions of years of evolution. Nature has developed a wide variety of biological assets which include metabolic pathways and genes of life on land and aquatic ecosystems and the natural products they produce – both chemical and material. These were developed in conjunction with biomimetic assets – the functions and processes used by Nature. Fourth Industrial Revolution (4IR) technologies are increasingly harnessing these assets across many industries from pharmaceutical to energy, food, cosmetics, materials and mobility, and making profits. However, to date, these profits have not been channeled back to conserve the Amazon and to support indigenous and traditional communities that are the custodians of the forests.

The Amazon Third Way may represent a new opportunity emerging to protect the Amazon ecosystems and the indigenous and traditional peoples who are their custodians and at the same time develop a vibrant, socially-inclusive “green economy” in the Amazon by harnessing Nature’s value through the physical, digital and biological technologies of the 4IR, resulting in a socially-inclusive, “standing forest, flowing river” new development paradigm.

As the region is still very disconnected from the main centers of technological innovation dealing with technologies of the 4IR and the advanced bio-economy, seeking ways to implement this disruptive novel paradigm can be seen as a multi-level path toward a new inclusive bio-economy. It is possible to integrate the fostering of a highly innovative, entrepreneurial and technological economy with the revaluation of non-timber forest and industries with low end technologies. The evolution of both paths will eventually lead to a vibrant and inclusive bio-economy, respecting the forest standing/flowing river mantra.

### **3 A SUSTAINABLE INFRASTRUCTURE FOR THE AMAZON**

To support a new standing forest-flowing rivers bioeconomy a completely new model of infrastructure consistent with a greener footprint sustainable development (McKenney *et al.*, 2016; IDB and IDB Invest, 2018) must be constructed that is radically distinct from the gargantuan infrastructure projects that dominated the Amazon scene for 5 decades, namely, tens of thousands of roads crisscrossing large tracts of forest, large dams for hydropower and transmission lines, and large mining operations, closely associated with the high

rates of land use change and forest clearing (Finer *et al.*, 2008; RAISG, 2012; Ahmed *et al.*, 2013; Barber *et al.*, 2014; Lees *et al.*, 2016; Barros *et al.*, 2020). Concurrently with the decline in deforestation rates in the Amazon from 2005 to about 2014 – especially in the Brazilian Amazon — the impetus for large infrastructure projects diminished for some years. For instance, no new large hydropower dams were planned for Brazilian Amazon by EPE – the state-owned energy planning company until recently. However, that trend may be reverted with the new government in Brazil (planning for new dams, paved roads) and in other Amazonian countries – closely linked to the Chinese Belt and Roads initiative (Laurance, 2018; Lawton, 2018; Castello and Macedo, 2016; Hyde, Bohlman and Valle, 2018; Laurance, 2019).

The infrastructure requirements to channel to the Amazon the benefits of a technology-driven bioeconomy for the creation of bio-industries for harnessing terrestrial and aquatic resources and for sustainable local development must be equally innovative and even disruptive. A new model for essential infrastructure must be created in tandem with a standing forest, flowing rivers green economy. It must challenge old-established paradigms of connectivity of distant points via a dense network of roads, centralized energy generation of hydropower dams or fossil fuel-fired power plants and transmission lines to export energy to distant centers. Or the idea of making many big rivers navigable through massive works of channel rectification to transport agricultural and mineral commodities.

This conceivable sustainable infrastructure needs to be distributed over a large area of over 6 million km<sup>2</sup> benefiting over five thousand local communities ranging from a few tens of people — mostly riverine populations – up to several thousand living in hundreds of small towns across the basin. It has to create a new infrastructure paradigm of “*distributed sustainable infrastructure*” for energy, transportation and mobility, strongly based on distributed renewable energy sources (solar PV, wind, in-stream turbines, vegetal oil mini-power plants, fuel cells and hydrogen). The potential of distributed solar PV over the Amazon — a tropical region with high incidence of solar radiation – is sufficient to feed this new bioeconomy and for all human needs of energy. It can be nicely combined with other sources such as wind energy in parts of the Amazon (*e.g.*, northern Roraima, Atlantic Coast etc.). Riverine communities can complement solar PV source with in-streams turbines (Moran *et al.*, 2018) that provide electricity 24h a day. Small towns can also benefit from existing diesel-fired generators, but switching to vegetal oil to be produced locally, enhancing the local economy and promoting gender balance (Mazzone, 2019).

A key element is for telecommunications to reach broadly and affordably all local populations via new and inexpensive communication satellites and fluvial fiber optics, as the example of fiber optics cable in the Amazon River all the way to the deeply inland town of Tefé. Transportation for this new local bioeconomies will rely mostly on zero-emission renewable energy powered fluvial transport — resting on the excellent natural riverine transportation opportunities – and drone technologies. Constellations of satellites and drones can also provide the means for monitoring, assessing and quantifying natural capital. RD&I must be applied also for appropriate housing and sanitation infrastructure, including those for flooded environments. Last but not least, this model relies equally on the advances of telemedicine to provide health care anywhere in the Amazon.

#### 4 THE AMAZON POPULATION AS PRIORITY

The Amazon Third Way Initiative seeks to demonstrate the urgent need for a conceptual, educational and entrepreneurial revolution – a revolution based on knowledge, traditional and scientific. The current economy of meat, grain and timber – that account for over 80% of deforestation – in the Brazilian Amazon in fact is not very significant given its low productivity. The economy associated to biological assets of Amazon biodiversity in a few industries (food, cosmetics, oils etc.) is already growing and distributes income in fairer ways and benefits more of the local population. However, that is a tiny portion of the potential of a sustainable economy hidden in the biological and biomimetic assets of Amazon biodiversity (Strand *et al.*, 2018; Soares-Filho and Rajão, 2018) that the Amazon Third Way initiative attempts to address and give visibility to those possibilities.

The Amazon forest is not a void of human presence. Diverse communities live all over the region. Even some communities of new settlers of the 1970s and 1980s have looked to find ways of generating income in agroforestry systems. There is rich traditional knowledge in many of indigenous, *caboclo*, and *quilombola* communities. Supporting the diversity of communities and economic pathways for a standing forest-flowing rivers economy is mandatory.

From a more general standpoint, sustainable development pathways based on natural resources exploitation should in principle put the local populations as priority. That is not the case for the Amazon currently (low HDI and other social indicators). Therefore, new sustainable paradigms must have the development policy as a central tenet. The sustainable economy should first and utmost means wellbeing to the Amazonian people. That is not the case of the Second Way, where the Amazon is seen important for intensive resource exploitation for the Amazonian countries as a whole and taxation of the resource wealth could in principle redistribute benefits as public services for all in the Amazon. However, a regressing taxation system does not realize that.

#### 5 THE NEED OF KNOWLEDGE GENERATION

The underlying principle of the Amazon Third Way initiative of harnessing Nature's values calls for enhanced capacity of knowledge generation about the unknown biological and biomimetic assets of Amazon biodiversity. That capacity must exist also within the Amazon countries and not only elsewhere if local development and equity is a goal to be sought after. Historically, the government budgets for S&T allocated to the Amazon have been disproportional to regional contribution to national GDP or to the proportion of people living in the region for all Amazonian countries. Particularly for Brazil, the regional GDP is about 11% of national GDP and its population of 25 million makes up for approximately 12% of Brazil's population. On the other hand, federal government budgets for Amazonian S&T institutions, including academic research in universities, account for less than 4% of national budgets. The result is that only about 3% of Brazil's PhDs work in the Amazon.

In the knowledge societies of the 21<sup>st</sup> century, capacity to generate innovative knowledge underpins any application leading to economic development. Even recognizing that globalization is making scientific discovery a global enterprise, it is a *sine qua non* condition that the ability to create knowledge must also take place in the Amazon, in order to leverage industrialization down the line, and foster local bio-industries as well. Public R&D are essential for underpinning this new model, but equally private R&D laboratories and startups in the region will be foundational. Attempts to create ecosystems



of innovation such as technological parks or clusters are facing great challenges in the Amazon. However, these innovation ecosystems in Brazil start initially with public expenditures to create the basis infrastructure, the public laboratories and the space for incubating start-ups and for housing private R&D laboratories, specially advanced biology laboratories in the Amazon.

The Amazon has a number of good examples of biology laboratories and a number of entrepreneurship initiatives that beyond economic development target social responsibility and deployment of sustainable biodiversity value chains. They are true pioneers into the new era of sustainability. However, they are as yet a small minority. They may even accrue national and international visibility and are role models, but in critically insufficient numbers to create momentum economically and socially to give clout to the rupture needed to put Amazon on a different track.

The new model must rely on these existing good examples, on the diversities of forest communities across the Amazon, on state-of-the art knowledge generation laboratories and innovative entrepreneurship and build up from there.

In due course, one has to build up momentum for enhancing the policies that are necessary to uplift the Third Way; investment in zero-deforestation value chains; reducing the enormous subsidies for commodities that drive deforestation; but as importantly invest in knowledge generation through a network of advanced biology laboratories in the Amazon, in Amazonian Countries and internationally in association with private R&D labs and science-based startups and creation of innovation ecosystems throughout the regions. That is a pre-requisite to the development of local next generation bio-industries in towns and cities of the future.

By attracting venture capital and productive investments both for R&D and for industries, the political interest in the Third Way will rise in the eyes of governments to a tipping point in which government investments and subsidies will start to flow to this other type of economy, even on the absence of visionary governments that would see the potential of a new Amazon bioeconomy and would design sustainable pathways to achieve it.

The implications of harnessing the 4IR to unlock the economic value of the Amazon's biological and biomimetic assets for governments, start-ups, corporations and R&D centers are profound. Partnerships among public and private R&D innovation labs to create a number of hubs of innovation throughout the region is necessary. This would accelerate new research and development leading to new products and innovations relevant for many industries locally and worldwide.

## **6 COMBATING THE CLIMATE CRISIS AND PROTECTING BIODIVERSITY**

The risk of a tipping point being transgressed for the Amazon must be a top priority for developing long term sustainable development policies for the region (Lovejoy and Nobre, 2019). That includes zero deforestation policies that are also essential to maintain essential ecosystem services for climate change mitigation such as carbon storage and removal from the atmosphere. If that point is crossed, large portions of the Amazon are probably turn irreversibly into some form of degraded savannas, providing much fewer environmental services, losing hundreds of billions of carbon dioxide, increasing global warming, and changing rainfall regimes regionally and even over remote regions such as the southern portions of the La Plata-Paraná basin that receives the transport of atmospheric moisture from the Amazon and contributes to rainfall.

We must recognize the urgency in disruptively altering the Amazon development model, especially in the direction of zero deforestation in order to reduce the risk of climate change — keeping about 120 billion tonnes of carbon safely stored in forest biomass, in addition to keeping forests functioning as carbon sinks — and reducing the loss of biodiversity, that is, the goal of zero deforestation should be achieved in less than a decade. But we must also draw long-term planning so that in the middle of the century we definitely left behind the prevailing resource-intensive mode of Amazonian development.

Also in the climate issue and the protection of biodiversity, a long-term planning for 2050 should be expected to restore a significant amount of the 1 million km<sup>2</sup> already deforested in the Amazon basin to serve as a carbon sink, that is, as a key natural solution to maximize the likelihood of success of the Paris Accord in keeping global warming below 2 C and ideally below 1.5 C. A fraction of these areas assigned for forest restoration can be converted into agroforestry systems: doing the ecosystem service of removing atmospheric CO<sub>2</sub>, but also containing higher density of species necessary for economic exploitation as recommended by the Amazon Third Way.

## 7 INVESTING IN PATHWAYS TOWARDS SUSTAINABILITY

Upon planning to reach full-fledged sustainability in the use of the natural resources of the Amazon, what are the trajectories of sustainable development that will lead us to such a future? (Aguiar *et al.*, 2012; Aguiar *et al.*, 2016). Or how can we “backcast” to the present sustainable development pathways from long term 2050 goals of sustainability for the Amazon?

It is top priority that the business investment model be changed towards sustainability. There are some initiatives in this direction, albeit incipient. Anticipating a worldwide movement for responsible production and consumption, one of the most important Sustainable Development Goals, investments begin to demand deforestation-free supply chains in commodities such as soybean and palm oil. The moratorium of soybean in the Brazilian Amazon started in 2006 and has produced a positive effect of decreasing the expansion of that agricultural crop on the rainforest, although there was leakage to the tropical forests of Bolivia. Investment fund initiatives for the economic exploitation of Amazonian biodiversity are beginning to emerge, albeit modest (United, 2019).

Similarly to what seems to be happening with respect to investment funds in the energy sector — abandonment of investments in fossil fuels and rapid transition to renewable energy for zero emission scenarios by 2050 — impact investments in the land use sector also need to migrate to sustainable uses of biodiversity and sustainable intensification of agriculture (Beddington *et al.*, 2012). Additionally, those investments must disruptively decelerate in activities that are at the root of the deforestation of tropical forests, such as gray infrastructure, agricultural commodities expansion, mining and large-scale energy.

Amazonian countries with immensely valuable natural assets would have an additional source of income to help protect these resources and support indigenous and traditional communities. These funds would create a new incentive on the part of communities and governments to protect rather than destroy natural habitats. The interest in understanding and sustainably using Amazon’s biological and biomimetic assets could propel a new era of scientific exploration of life on the planet. Large new markets for sustainably sourced innovation could be created. Technology companies and start-ups seeking to demonstrate compliance with the Nagoya Protocol of access to genetic resources and benefit sharing could be certified, through the transparency that distributed ledger technology offers.



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We must seek for a “great acceleration” of disruptive transformations of social-ecological systems in desired direction for sustainability. Part of the solution should aggressively embrace high-tech innovation and look at the Amazon as a tremendous source of biological and biomimetic assets that can provide new, innovative products and services for current and new markets. System-level change in the Amazon as proposed cannot be executed single-handedly. On the contrary, collaboration with leading public, private, academic and philanthropic actors for the journey ahead, engaging Indigenous and traditional communities across Amazonian countries, uniting the best capabilities of regulators, R&D centers, universities, technology startups and visionary companies all over the world.

In summary, the long-term goals for 2050 and beyond to achieve the Sustainable Development Goals, respecting the planetary boundaries (Steffen *et al.*, 2015), should guide the investment policies in sustainable business and in the appropriate R&D for the present and the immediate future for the sustainable use of Amazonian biodiversity resources.

## 8 CONCLUSIONS

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If successful, this new development model can be applied to all tropical regions helping to preserve the Earth's great biological diversity. We have an important choice to make. The future of the Amazon and its impact on the planet lie so clearly in the balance. Time is not on our side, but we can still choose the Third Way.

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