Saving the Amazonia must not only be a heroic feat of its natural trustees but a crusade that all humankind can no longer defer….
Drawing on today technologies but also, on the wisdom accumulated for centuries by Amazonia itself: The Amazonia Standing[1]

Scientific Framework to Save the Amazon

By
Scientists of the Amazon Countries and Global Partners

September 30, 2019

We, the scientists who study and monitor the Amazon rainforest, appeal to the reason and conscience of humankind. The Amazon, the largest rainforest in the world, is at great risk of destruction, and with it the well-being of our generation and generations to come.

The Leticia Pact, adopted in September 6, 2019 by the governments of the region highlights the importance of research, technology and knowledge management to guide decision-making vis-à-vis the Amazon[2]. We concur in this call for a concerted and urgent scientific and technological effort to protect the Amazon.

The Amazon is a place of immense natural and cultural wealth and diversity. Formed more than 30 million years ago,[3] it harbors a tenth of all species on Earth. It has been inhabited by indigenous peoples for more than 11,000 years.[4] Its legal boundaries span roughly 8.5 million km^2—about 12 times the size of the U.S. state of Texas and 28 times the size of the country of Italy—and stretch across the territory of eight countries: Bolivia, Brazil, Colombia, Ecuador, Guyana, Peru, Suriname, Venezuela[5] and a territory (French Guyana). About 5.5 million km^2 of this area is forested.

The Amazon is the greatest repository of biodiversity in the world, home to around 10% of all the world's known species of plants and animals. It contains nearly half of all trees found in the

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[1] Gabriel Garcia Marquez, Foreword of Amazonia without Myths: Report of the Commission on Development and Environment for Amazonia, UNDP and IDB, 1992.

[2] Paragraph 13 of the Leticia Pact states: "Promote research, technological development, technology transfer and knowledge management processes with the purpose of guiding the appropriate decision making and promoting the development of sustainable environmental, social and economic enterprises."

[3] Burnham, Robyn J, and Kirk R. Johnson. (2004). South American paleobotany and the origins of neotropical rainforests. Phil. Trans. R. Soc. London. B 359(1450): 1595-1610.

[4] Roosevelt, A.C. et al. (1996). Paleoindian cave dwellers in the Amazon: the peopling of the Americas. Science 272(5260): 373-384.

[5] RAISG (2019). Amazonia 2019: Protected Areas and Indigenous Territories. https://www.amazoniasocioambiental.org/en/maps/#!/areas

world's tropical forest regions[6], an estimate of 16,000 species in total[7]. In fact, in just two hectares this wondrous rainforest harbors more species of trees than in all North America[8], and on just one of these trees, there may be as many species of ants as in all of England[9]. The Amazon's tributary rivers and streams also host a remarkable diversity; over 44 species of fish can be found in a short stretch of stream, and 2,300 species across the basin as a whole, more than can be found in the entire Atlantic Ocean.

It is a source of enormous cultural diversity, too.[10] More than 35 million people call this wondrous expanse home, including nearly one million indigenous peoples from around 400 distinct groups, with their own cultural identities, territorial management practices,[11] and languages. This cultural richness is complemented by communities of *quilombolas*, or descendents of African slaves, and a diverse range of traditional peoples utilizing forest and river resources.

The Amazon plays a critical role in global water cycles. Its rivers hold one fifth of all the fresh water of the planet, and the Amazon River is the largest tributary to the world's oceans.[12] The Amazon basin supports high ecological, hydrological, and climatic diversity from the Andes to the floodplains, as well as savannas on northern and southern flanks of the basin.[13]

The forest itself helps to regulate global climate variability, including the El Niño-Southern Oscillation or ENSO phenomenon and rainfall patterns at local and regional scales, providing favorable conditions for agricultural production and food security across the continent.[14] Daily, evapotranspiration releases 22 billion tons of water from Amazonian soils to the atmosphere. Around 50% of the area's rainfall originates as evapotranspiration from the forest itself (precipitation recycling),[15] and explains why rainfall along different continental transects over South America exhibit an exponential increase with distance from the Atlantic Ocean.[16]

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[6] Crowther, T.W. et al (2015). Mapping tree density at a global scale. *Nature* 525:201-205.

[7] Steege, Hans *et al.* (2013). Hyperdominance in the Amazonian tree flora. *Science* 342(6156).

[8] https//www.livescience.com/55387-how-many-trees-in-amazon.html

[9] Wilson, E. O. (1999). The diversity of life. WW Norton & Company.

[10] High-Level Panel of Experts on Food Security and Nutrition. 2017. Sustainable forestry for food security and nutrition. Committee on World Food Security, Rome. http://www.fao.org/3/a-17395e.pdf

[11] https://www.survivalinternational.org/about/amazontribes

[12] Smith, Nigel J.H(2002). Amazon Sweet Sea: Land, Life, and Water at the River's Mouth(s.l.): University of Texas Press.pp1-2

[13] Encalada et al. 2019. A global perspective on tropical montane rivers. Vol. 365, Issue 6458, pp. 1124-1129 DOI: 10.1126/science.aax1682.

[14] Lawrence, Deborah and Karen Vandecar. (2015). Effects of tropical deforestation on climate and agriculture. *Nature Climate Change* 5: 27-36.

[15] E. Salati, A. Dall 'Ollio, E. Matsui, J. R. Gat, Recycling of Water in the Amazon, Brazil: an isotopic study. Water Resour. Res. 15, 1250–1258 (1979).

[16] Staal, et al. (2018). Forest-rainfall cascades buffer against drought across the Amazon. *Nature Climate Change* 8: 539-543.

Around 70% of South America's GDP is produced in areas receiving rain produced by the Amazon,[17] including the tropical and subtropical Andes. The Amazon drives large-scale atmospheric circulation patterns and aerial rivers, while the Andes Cordillera enhances cloud formation and rain, allowing for maximum rainfall over the western Amazon.[18] This produces rainfall for tropical glaciers, páramos, punas, and yungas over the Andes, and provides water for large cities like Bogotá, Quito, Lima, and La Paz.

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In turn, the Andes provide runoff and stream flows to the low-lying Amazon, transporting sediments and nutrients required to sustain the extraordinary biodiversity of the region.[19] The low-lying Amazon and the Andes constitute a coupled hydroclimatic, biogeochemical and ecological system operating at a wide range of timescales.[20] [21] Water vapor transported by the winds from the Amazon are also crucial for the supply of water of southeastern South America and the La Plata River basin [22].

During high-water months of the year, the Amazon and its tributaries rise and flood surrounding forests for months at a time. The annual flood cycle provides for a floodplain "pulse "sustaining agricultural practices that have been used for millennia. The river also harbors an immense freshwater diversity with more than 4000 fish species. Freshwater fisheries are particularly important for local and regional development and as a source of protein and play key roles in ecological function. Those forest and fish need to be managed sustainably, which local communities have done for centuries. However, the likely interaction of global climate changes with deforestation-induced regional changes could increase the severity of floods and droughts.[23] In fact, three extremes droughts (2005, 2010, and 2015-2016) and two extreme floods (2009, 2012) hit the basin in 12 years, a sequence of extremes not observed in over 100 years of river measurements in the Rio Negro in Manaus.[24]

The Amazon is also a critical buffer against climate change. It absorbs about 20% to 25% of the 2.4 billion metric tons of carbon absorbed annually by the forests.[25] The entire Amazon stores

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[17] Nobre, Antônio Donato (2014). O Futuro Climático da Amazônia: relatório de avaliação científica. São José dos Campos, SP: ARA: CCST-INPE: INPA.

[18] Figueroa, S. N.; Nobre, C. A. Precipitation distribution over central and western tropical South America. **Climanálise**, v. 5, n. 6, p. 36 - 40, 1990.

[19] P. Vauchel et al., J. Hydrol. 553, 35 (2017)

[20] G. Poveda, P. R. Waylen, R. Pulwarty, Palaeogeog. Palaeoclim. & Palaeoecol. 234, 3 (2006).

[21] L. A. Builes-Jaramillo, G. Poveda, Water Resour. Res. 54, 3472 (2018).

[22] Arraut, J. M.; Nobre, C. A.; Barbosa, H. M. J.; Obregón Párraga, G. O.; Marengo, J. A. Aerial Rivers and Lakes: Looking at Large-Scale Moisture Transport and Its Relation to Amazonia and to Subtropical Rainfall in South America. **Journal of Climate**, v. 25, p. 543 - 556, 2012. Doi: 10.1175/2011JCLI4189.1.

[23] Nobre, C. A.; Borma, L. S.. 'Tipping points' for the Amazon forest. **Current Opinion in Environmental Sustainability,** v. 1, p. 28 - 36, 2009. doi:10.1016/j.cosust.2009.07.003.

[24] Borma, L. S.; Nobre, C. A.. (Org.). **Secas na Amazônia: Causas e Consequências**. 1 ed. São Paulo: Oficina de Textos, 2013, 367.

[25] https://www.sciencemag.org/news/2015/03/amazon-rainforest-ability-soak-carbon-dioxide-falling

nearly 100 billion metric tons of carbon—about a decade's worth of global emissions[26][27]. In addition to carbon sequestration, the Amazon provides cooling through evapotranspiration[28] [29] an overlooked environmental service. The Amazon provides invaluable and fundamental life support systems related to water, air, soils, forests and biomass.

Because of the intense transformation that took place during the last decades, the role that the agricultural sector can play in climate change mitigation is of critical importance. In consolidated colonization frontiers, it is essential to develop and implement pathways towards sustainable territorial management based on innovative frameworks that enhance sustainable agriculture productivity and improves the livelihood of rural population. The production of timber and non-timber forest products such as Brazil nuts, rubber, and açai berries, also supports millions of lives and contributes to the national economies.[30]

But today the Amazon and its inhabitants are threatened with extinction. Its agony poses a dramatic threat to human well-being.

It wasn't always this way. For many years in the recent past, Amazonian countries have acted with perseverance and courage to preserve its natural and cultural wealth. In total, about 47% of the Amazon has been designated as indigenous territories and protected areas[31]. Between 2002 and 2009, Brazil led the world in the creation of protected areas (including demarcated indigenous lands), expanding its protected area network by more than 700,000 km^2 in less than a decade.[32] The demarcation of indigenous lands also protected forests,[33] since average deforestation rates inside legally-recognized indigenous lands are 2-3 times lower than in similar protected areas outside[34] of indigenous territories. Amazonian indigenous territories contain more than one third of the region's aboveground carbon.[35] In the Brazilian Amazon,

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[26] Brienen et al. 2015 Long-term decline of the Amazon carbon sink. *Nature* **519**, 344–348.

[27] https://www.globalcarbonproject.org/

[28] Rocha et al., 2009. Patterns of water and heat flux across a biome gradient from tropical forest to savanna in Brazil, J. Geop. Res.

[29] Saleska et al., 2009. Ecosystem Carbon Flux and Ecosystem Metabolism. In: Keller et al (Eds). Amazonia and Global Change. Geophysical Monograph Series 186. AGU.

[30] Strand,Jon, Britaldo Soares-Filho, Marcos Heil Costa, Ubirajara Oliveira, Sonia Carvalho Ribeiro, Gabrielle Ferreira Pires, Aline Oliveira, Rajao Raoni, May Peter, van der Hoff, Richard and Siikamaki,Juha, Ronaldo Seroa da Motta& Michael Toman, 2018. Spatially explicit valuation of the Brazilian Amazon Forest's Ecosystem Services.*Nature Sustainability, 1(11). P.657*

[31] RAISG (2019)

[32] Soares-Filho, Britaldo *et al.* (2010). Role of Brazilian Amazon protected areas in climate change mitigation. *Proceedings of the National Academy of Sciences* 107(24): 10821-10826.

[33] Blackman, Allen and Peter Veit (2018). Titled Amazonian indigenous communities cut forest carbon emissions. *Ecological Economics* 153: 56-67.

[34] Ding, Helen *et al.* (2016). Climate benefits, tenure costs: the economic case for securing indigenous land rights in the Amazon. World Resources Institute.

[35] Walker, Wayne *et al*. (2014). Forest carbon in Amazonia: the unrecognized contribution of indigenous territories and protected natural areas. *Carbon Management* 5:5-6.

protected natural areas alone (not including indigenous land) are responsible for conserving 36,4 billion tCO2eq., or 34% of the total carbon stock.[36]

Thanks to the demarcation of indigenous territories and protected areas, effective law enforcement in these lands, and new investments to prevent illegal deforestation and fires, deforestation declined between 2004 and 2012, especially in Brazil (85% reduction in deforestation).[37] The reduction of deforestation allowed Brazil to reduce its carbon emissions more than any other country.[38] Brazil's agricultural production from the Amazon continued to grow during this period of reduced deforestation;[39] it is clearly possible to increase agricultural production and exports without deforestation. Indeed, most deforestation occurs to support unproductive activities, such as cattle ranches that are abandoned after a decade or so, pushing deforestation further into the forest.

However, despite the promises of deforestation–free agreements, in recent years there has been a renewed threat from the expansion of inefficient cattle ranching, low-productivity agriculture, and mining, violating of the land and resource rights of indigenous peoples and local communities as well as causing deforestation. Cattle ranching – often linked to illegal land speculation – continues to drive the bulk of deforestation, but legal and illegal mining and infrastructure are growing threats. Close to 70% of protected areas and indigenous territories in the Amazon are now threatened by roads, mining, oil and gas development, illegal invasions, dams, or deforestation.[40] Alluvial gold mining is polluting rivers with mercury and arsenic. Plans to open up the last wilderness areas in the Peruvian, Bolivian, and Brazilian Amazon will bring a new wave of land grabbing and deforestation.

The very large rise in fires in 2019 confirms the dramatic upward trend in deforestation. The recent data are staggering. There have been an estimated 87,000 fires in Brazil during the first eight months of 2019, up more than 90% compared with 2018.[41] More than 45,000 of these fires have been in the Brazilian Amazon. Dense smoke plumes[42] from these fires are a health hazard to tens of millions in South America. Between January and July 2019, Brazil's National Institute for Space Research (INPE)'s DETER system which captures about 50 to 60% of total deforested area, indicated that 4,699 km^2 were razed in the Brazilian Amazon, nearly double the 2,810 km^2 lost during the same period in 2018.[43] An area of forest the size of Luxemburg

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[36] Young, Carlos Eduardo Frickmann and Medeiros, Rodrigo. Quanto vale o verde: a importância econômica das unidades de conservação brasileiras.Rio de Janeiro: Conservação Internacional, 2018, v. 1.

[37] Boucher, Doug *et al*. (2013). Brazil's success in reducing deforestation. *Tropical Conservation Science* 6(3): 426-445.

[38] https://www.climateadvisers.com/who-cut-the-most-brazils-forest-protection-has-achieved-twice-us-emissions-reductions/

[39] Nobre et al. Land-use and climate change risks in the Amazon and the need of a novel sustainable development paradigm.Supplmentary Information. Proc Natl Acad Sci, v. 113, n. 39, p. 10759 – 10768, 2016. Doi: 10/1073/pnas.1605516113.

[40] https://news.mongabay.com/2019/06/amazon-infrastructure-puts-68-of-indigenous-lands-protected-areas-at-risk-report/

[41] INPE Programa Queimadas. http://queimadas.dgi.inpe.br/queimadas/portal-static/situacao-atual/

[42] https://earth.nullschool.net/#current/particulates/surface/level/overlay=pm1/orthographic=-40.58,-12.00,285.

[43] INPE TerraBrasilis. http://terrabrasilis.dpi.inpe.br/app/dashboard/alerts/legal/amazon/aggregated/#

was lost in the month of July alone. Ground validation may well reveal even more deforestation than that visible in satellite imagery. The soaring rates of destruction reflect a staggering increase of illegal economic activity matched by a devastating decline in enforcement efforts. And deforestation does not just affect the area that has been lost as the remaining forests are often degraded by selective logging, forest fires and fragmentation, doubling the biodiversity loss from deforestation.

The entire world is rightly alarmed. These forests fires are a classic example of a "chronic emergency," that is, an emergency caused by disastrous long-standing practices. To address this situation, a systematic, long- term strategy for prevention as part of a sustainable development plan for the Amazon region is urgently needed. The current crisis offers an opportunity to make a decisive shift towards sustainable development and to avoid "tipping points," beyond which the rainforest can no longer sustain itself.

Deforestation and forest degradation are not only an environmental problem; they also have severe social impacts. Indeed, statistical evidence shows that homicides increase with deforestation[44] due to the violent process of land squatting and grabbing which displaces traditional communities and intensifies the spread of diseases[45]. In western Amazonian countries international mafias related to narco-trafficking, illegal logging and illegal mining cause vast suffering through human trafficking, coerced labor and murders.

In addition, forest degradation caused by illegal and unsustainable logging practices is an important issue that must be addressed. Degraded forests are much more fire-prone than primary forests, and they no longer constitute a natural barrier to fires. Understanding the ecology and the dynamics of those "degraded" forests is vital to fight against fire in the Amazon.[46] [47]

And things may get worse, as many models predict that as deforestation increases and climate change progresses, droughts intensify, and fire risks rises,[48] as was the case when over 1 million hectares mega-wildfire burned the forests of Santarem region during the 2015-16 El Niño. These forest fires threaten the ability of the forest Amazon to act as a carbon sink in the short

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[44] SANT´ANNA, André Albuquerque (2017). Land inequality and deforestation in the Brazilian Amazon. Environment and Development Economics, Volume 22, Issue 1 February 2017, pp. 1-2. 5. DOI: https://doi.org/10.1017/S1355770X1600022X.

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https://doi.org/10.19182/agritrop/00012

[47] Bourgoin Clement, Blanc Lilian, Bailly Jean Stephanie, Cornu Guillaume, Berenguer Erika, Oszwald Johan, Tritsch Isabelle, Laurent Francois, Hasan Ali Fadhil, Sist Plinio, Gond Valery, 2018. The potential of multisourse remote sensing for mapping the biomass of a degraded Amazonian forest. *Forests.*9(6) 303,21p,
H=https://doi.org/10.3390/f9060303

[48] Aragao, Luiz Edardo O.C. *et al*. (2008). Interactions between rainfall, deforestation, and fires during recent years in the Brazilian Amazonia. *Phil Trans. R. Soc. B. 363: 1779-1785*

and long-term, further exacerbating the climate crisis.[49] In the long-term, the high mortality of trees reduces the ability to sequester carbon in the future[50] , while the burning material and leaf litter releases significant CO_2 emissions[51] in the short-term.

Moreover, the Amazon did not co-evolved with fires and as such it does not has mechanisms for a rapid post-fire recovery; for example, 30 years after a fire, burned forests still store 25% less carbon than unburned forests.[52] Burned forests also hold a distinct group of species than that of previously undisturbed forests,[53] resulting in functionally different plant communities, which ultimately impact ecosystem processes such as carbon storage.[54] Between the impacts of deforestation and climate change, tree species diversity in the Amazon could decrease by almost 40% by 2050.[55] And that is just the beginning of the problem.

Deforestation to date, which affects nearly 17% of the total Amazon rainforest, threatens the survival of the entire ecosystem, by endangering biodiversity and changing the water cycle vital for the survival of the rainforest. The Amazon as a whole is near the tipping point of collapse. [56] [57] Indeed, parts of it – most notably the regions affected by vast forest fires – have probably already flipped to an entirely different system that will take many decades or centuries to recover. Moreover, human-induced global warming endangers the Amazon from outside of the Amazon basin by threatening a catastrophic decline of rainfall within the Amazon basin and in downwind areas, jeopardizing water and energy security[58], agricultural productivity and food security and biodiversity. Observations indicate that indicate that in over 50% of the Amazon basin the dry season is already several weeks longer, particularly over deforested areas.[59] Coupled with increased temperatures, this has caused declines in the forest ability to act as carbon sink.[60] Further there has been changes in the distribution of plant species to favor

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[49] Aragao, Luiz E. O. C. *et al* (2018). 21st century drought-related fires counteract the decline of Amazon deforestation carbon emissions. *Nature Communications* 9(536)

[50] Barlow, J. , Peres, C. A., Lagan, B. O. and Haugaasen, T. (2003), Large tree mortality and the decline of forest biomass following Amazonian wildfires. Ecology Letters, 6: 6-8. doi:10.1046/j.1461-0248.2003.00394.x

[51] Withey 2018 https://royalsocietypublishing.org/doi/abs/10.1098/rstb.2017.0312

[52] Silva et al 2018 https://royalsocietypublishing.org/doi/abs/10.1098/rstb.2018.0043

[53] Barlow et al 2016 https://www.nature.com/articles/nature18326

[54] Berenguer, E, Gardner, TA, Ferreira, J, et al. Seeing the woods through the saplings: Using wood density to assess the recovery of human-modified Amazonian forests. *J Ecol*. 2018; 106: 2190– 2203. https://doi.org/10.1111/1365-2745.12991

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[56] Lovejoy, Thomas E. and Carlos Nobre. (2018). Amazon tipping point. *Science Advances* 4(2): 2340.

[57] Nobre et al. Land-use and climate change risks in the Amazon and the need of a novel sustainable development paradigm. Proc Natl Acad Sci, v. 113, n. 39, p. 10759 – 10768, 2016. Doi: 10/1073/pnas.1605516113.

[58] Stickler, Claudia M. *et al.* (2013). Dependence of hydropower energy generation on forests in the Amazon Basin at local and regional scales. *Proc Natl Acad Sci* 110(23): 9601-9606.

[59] Leite-Filho at al., 2019. Effects of Deforestation on the Onset of the Rainy Season and the Duration of Dry Spells in Southern Amazonia. *J. Geophys. Res. Atmos.* **124**, 5268–5281.

[60] Brienen et al. 2015 Long-term decline of the Amazon carbon sink. *Nature* **519**, 344–348.

more drought- tolerant species.[61] We may be much closer than expected to the tipping point and the savannization of 50-60% of the total forest.

The Amazon rainforest constitutes an interconnected ecosystem and should be managed as such to avoid irreparable ecosystems and biodiversity loss, to safeguard the enormous amount of carbon and biodiversity in those forests and to ensure the wellbeing of the people who live there and depend on the forest. The Amazon is also closely interwoven with the South America climate system, so its survival affects for societies and nature in neighboring regions as well.

As the Encyclical "*Laudato si'* states, there is an "ecological debt" vis-à-vis the Amazon, related to commercial imbalances with severe impact on the environment, and the exploitation of natural resources by some countries over long periods of time. The climate and biodiversity crises of the Amazon are illustrative of a globalization of indifference for the well-being of humanity, with governments that are unresponsive to its global needs.

We must keep in mind that this climate crisis in the Amazon produces the globalization of indifference, the most serious forms of which are human trafficking, modern slavery, forced labor, prostitution and organ trafficking

What transpires in the Amazon in one country affects the Amazon in all countries and even productive areas outside the Amazon. What happens in the Amazon affects the entire world and what happens globally impinges directly on the health and survival of the Amazon rainforest. Saving the Amazon therefore requires actions within the Amazon itself as well as complementary global actions to stop human-induced climate change.

We, scientists of the Amazon and those who study the Amazon, put forward our recommendations with an appeal to governments, businesses, civil society, and people of good faith everywhere to join in a common effort for the sake of humanity and Earth today and into the future.

We hold the ***following principles*** to be based on national and international law, established science, and sound ethical principles.

First, the Amazon forest lies within the sovereign territory of eight nations and one national territory. No nation outside the Amazon may threaten the territorial integrity or sovereignty of the Amazon nations and the Amazon rainforest, in violation of international law and especially the protection of the UN Charter.

Second, the Amazon rainforest is the home of more than 30 million people, including indigenous and traditional populations. At the same time, most Amazonian residents now live in cities – these include some of the most violent cities in the world, with vast favelas and high

[61] A. Esquivel-Muelbert, *et al.*, 2017 Seasonal drought limits tree species across the Neotropics. *Ecography (Cop.).* **40**, 618–629.

levels of poverty. The sustainable management of the Amazon must respect the dignity and rights of the people of the Amazon.

Third, the Amazon rainforest is a vital ecosystem for the entire planet and a part of the irreplaceable heritage for all of humanity. While stewardship rests first and foremost with the nations of the Amazon, this responsibility must also be shared globally. A plan to save the Amazon must be shaped and executed by Amazonian countries but supported by nations everywhere. When it comes to financial support, the richest ones have a deep responsibility both as buyers of products from areas with deforestation and for their accumulated GHG emissions. Global cooperation and mutual responsibility is essential for the survival and sustainability of the Amazon rainforest.

Fourth, the management of the Amazon must be based on sound scientific principles and must draw upon the active research, monitoring, and recommendations of the world's leading scientists, especially those from Amazon countries, who are most deeply engaged in the needed research, monitoring, and scientific advisory activities. At the same time, it must also give precedence to the traditional knowledge and practices of Amazonia's indigenous peoples, who have managed these forests for millennia. The sustainable management of the Amazon should explore science-based options for the sustainable development of an innovative bio-economy, sustainable infrastructure; overall management of the Amazon river, its tributaries and floodplains, and Amazon fisheries management.

Fifth, the state of the Amazon rainforest must be monitored closely in view of the dire threats facing the region. Daily satellite data, backed by spatially distributed long-term ground monitoring, enables crucial real-time and accurate monitoring of deforestation, forest fires, and other threats to the Amazon, and enables the quantitative monitoring of road-clearing, logging, cattle ranching, mining and other activities beyond the legal and ecological limits of the rainforest. *In-situ* data are also crucial to validate on the ground satellite data and information. The scientific community will work together to develop a platform for early warning of the risks to the whole forest to ensure that these crucial data sets are available worldwide in near real-time, in addition to providing science-based predictions of near- and long-term risks to the forests.

Sixth, no business entity anywhere has the right to market products or engage in commercial activities that threaten the survival of the Amazon rainforest and the people who depend on its conservation. Deforestation caused by the expansion of logging, cattle ranching, soybean production, mining, hydropower, road infrastructure and other industries, including illegal activities such as drug trafficking and smuggling of minerals and native flora and fauna, threatens the rainforest and violates the rights of indigenous peoples and traditional communities. Many of these activities generate meager economic benefits and profound social costs. Agriculture, mining and hydropower must be kept strictly within lands approved for such activities based on sound scientific criteria. Furthermore, greater focus should be given to improving productivity in already cleared areas and emphasis should remain on highly productive activities by adopting state-of-the-art technologies and best practices. Any

development must fully avoid or mitigate any collateral outcomes, such as the mass migration and land speculation can lead to violence and clearance or degradation of surrounding forests.

Seventh, all companies trading and utilizing products originating from the Amazon—including investment funds and portfolios--are responsible and accountable for the sustainable production of such products. Consumers should be availed of all information regarding any companies and product lines that threaten the viability of the Amazon rainforest. This demands timely, transparent and easily accessible information for all stakeholders: government, civil society, academia, and scientists. We also recognize that certification and sustainable practices will only be adopted at scale when illegal activities are effectively curtailed.

Eighth, the large-scale forest restoration plans put forth by Amazonian countries' Nationally Determined Contributions to the Paris Accord must be high priority. Forest restoration over southern and eastern Amazon are urgently needed because of the worrying signs of a proximity to a tipping point of collapse of the forest on those portions of the basin.

Ninth, it is more urgent than ever to find alternative paths towards sustainable development of the Amazon. Over the last decades, the Amazon debate has been torn between attempts to reconcile two rather opposing views of land use: a vision of setting aside large tracts of the of the Amazon rainforest for conservation purposes and one seeking a "resource-intensive development," focused agriculture, livestock, energy and mining. However, we have an opportunity to develop a new sustainable paradigm that ensures that the forest is worth far more standing than cut down, and that freshwater resources are managed sustainably. Using best science and advanced technologies we can save the rainforest, protect the Amazon's ecosystems and indigenous and traditional peoples, and still take advantage of sustainable economic activities for an innovative bio-economy: standing forest-flowing rivers bio-economy. And by harnessing new technologies, and high-value bio-industries it could include pharmaceuticals to foods, cosmetics, materials and others, strictly managed within clear and firm ecological limits, while protecting the social rights for participating people, and backed by effective monitoring, evaluation, and rigorous enforcement. It is estimated that the Brazilian Amazon has 10 million ha of degraded, deforested and non-productive lands that could be restored for agriculture, but mostly to agroecological systems to yield forest products for a new bio-economy. Deforestation[62] to convert forest into agricultural lands is no longer necessary.

The Amazonian countries have historically underinvested in such a model and relied instead on low-productive and land-intensive activities. In the Amazon the system with the best chance of allowing both people and forest to thrive is a nature-based knowledge economy that makes discoveries and innovations by combining tradition and scientific knowledge while reversing deforestation and land degradation.

Based on these principles, we put forward the following **Eleven-Point Scientific Framework:**

[62] Zero deforestation working group. 2017. A pathway to 0 deforestation in the Brazilian Amazon. 33 pages

(1) Immediate and urgent actions to halt and control the spread of forest fires using science-based interventions and monitoring techniques. Immediate and urgent actions to prevent forest degradation and support strategic restoration activities. Avoiding degradation will require bringing forest fires under maximal control using evidence-based interventions, near-real time monitoring techniques and supporting combat; and preventing illegal logging. Restoration should be encouraged in landscapes that have lost most of their forest, to support connectivity for biodiversity, and to lessen the impacts of climate change such as by reducing urban temperatures, and, most relevant, to reduce the risk of a tipping point of savannization of large portions of the forest.

(2) An immediate end to all legal and illegal deforestation and land use changes in the rainforest in all Amazonian countries, covering logging, mining, farming, ranching under existing national codes, including the removal of subsidies and other indirect incentives for predatory activities, restricting access to public credit and international development assistance to illegal deforesters and to the companies that are directly benefiting or buying from illegally deforested areas in the Amazon.

(3) A return of full funding for all national enforcement and monitoring agencies with international financial support as necessary and requested. Expanded support for enforcement of existing law on land use, land tenure and human rights. There can be no sustainability without enforcement.

(4) Promote evidence-based management through the immediate establishment of a "Science Panel for the Amazon" (SPA) with membership to include scientists from public and academic sectors of all Amazonian countries and partner scientists of other nations. Local, traditional and indigenous forms of knowledge will be integrated into the SPAS as well.

(5) A SPA report to be published no later than July 2020 on the relevant metrics, milestones and guidelines for the sustainable management of the Amazon, based on environmental, social and economic sciences, including new opportunities for sustainable businesses in forestry, agriculture, fisheries, mining, ecotourism, and other activities. The SPA will also develop an agenda for science, technology, innovation and investment that promotes a nature–based, standing-forest, flowing rivers knowledge economy.

(6) An ongoing and timely review of major infrastructure projects with regard to their potential environmental impacts.

(7) By the end of 2020 a commitment to provide evidence to support the upgrading of forest codes and laws in all eight Amazon countries and French Guiana based on the recommendations of the SPA, and the constitutional protections of human rights and environmental sustainability.

(8) To support the reactivation and expansion of the Amazon Fund to cover the whole basin with increased international funding for at least $1 billion per year to co-finance scientific

research and innovation, forest conservation, forest restoration of degraded lands, carbon storage services, freshwater restoration and community monitoring and sustainable management of the rainforest and its biodiversity in the Amazon region. This should include a designated fraction of resources allocated to capacity development of Amazon science and appropriate higher education (e.g., training fellowships for undergraduates, graduate students and post-doctoral trainees to pursue degrees and research projects). The SPA will provide estimates of funding requirements.

(9) The protection of all indigenous peoples and communities against illegal, unauthorized, or undocumented land-grabbing, logging, mining, farming and ranching on indigenous lands, and all acts of violence and hate crimes against indigenous and forest peoples, and the speedy and accurate completion of all pending demarcations of indigenous lands. And the assurance that all protected areas are effectively managed against illegal, unauthorized, or undocumented land-grabbing, logging, mining, farming and ranching within their perimeters and buffer zones.

(10) The monitoring and certification of all agricultural, fisheries and mineral supply chains originating in the Amazon rainforest (including but not limited to soybeans, coffee, meat, timber and non-timber products, minerals) for compliance with national and international sustainability agreements, with publicly available data on all companies engaged in global supply chain activities in connection with non-Amazonian member states, in particular those who have agreed with the Amsterdam Declaration. And full transparency of supply chain in order to ensure the compliance with deforestation-free trade agreements and national legislation.

(11) The protection and expansion of real-time scientific monitoring of Amazon rainforest conditions (including satellite data, remote sensing, and ground observations) to enable implementation of a platform for early warning of risks to the forest and rivers.

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