

🧠👉 The inclusive bioeconomy; the future of Amazon; synthetic biology, and fires from the space++ #249

Could a new paradigm protect the environment and advance economies?

Azeem Azhar Dec 21, 2019 ❤️ 52 💬 2 📄

Hi, I'm [Azeem Azhar](#). I'm exploring how our societies and political economy will change under the force of rapidly accelerating technologies and other trends.

Every few weeks, I invite a reader to take over *Exponential View* and give you a different perspective. I'd got to know Juan Carlos Castilla-Rubio after he connected with me around his work on the Earth BioGenome Project. We had a chance to spend some time together in Dubai at the World Economic Forum meeting, and I wanted to give him the opportunity to tell his story.

Please enjoy Juan Carlos' *Exponential View* — and take a moment to thank him by hitting the heart above, leaving a comment or sharing on social media.

Azeem

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📄 P.S. If you want to catch up on all the phenomenal *State of the Exponential* conversations we had this year, [our archive is now ready!](#) We'll keep updating it as new conversations happen.

About Juan Carlos Castilla-Rubio

My name is Juan Carlos, I am the chairman of SpaceTime Ventures where we dream up, create and operate science-based ventures focused on making natural resources and nature's intelligence actionable for global impact. I am also a member of the World Economic Forum's Global Advisory Council. In this role, I've been designing and incubating innovation programmes to address global issues in energy, food and water security, climate risk management, tropical ecosystem protection and biodiversity genomics, for the last ten years.

After I failed miserably with my first biotech startup as a young biochemical engineer in the Peruvian Amazon thirty-five years ago, I abandoned biology, only to return four years ago to the process of 're-learning biology'. I became the founder of the Earth Bank of Codes, a founding member of the Working Group of the Earth BioGenome Project and the founder and chairman of Pivotal Genomics.

In my *Exponential View* dedicated to the decoding of the Book of Life and the emerging bioeconomy innovation roadmap, I will start by reflecting on the world close to me here in Brazil and my home country of Peru, but crucial to us all—the world's largest library of biological knowledge, the Amazon rainforest.

Find me on Twitter [@juanccas](https://twitter.com/juanccas).

The future of the Amazon and the future of us all

The Amazon plays a critical role in the global water cycle. Its rivers hold one fifth of all the fresh water on the planet. The Amazon River is the largest tributary to the world's oceans. The Amazon helps to regulate climate and rainfall patterns at local and regional scales, providing favorable conditions for agricultural production across the South American continent. Over the last few years it has become the de facto 'breadbasket' for the world with 40 per cent of the growth in supply by 2030 coming from Brazil alone. Around 70 per cent of the South American GDP is under the zone of influence of the rain produced by the Amazon.

The Amazon is also a critical buffer against climate change. It absorbs about 20 to 25 per cent of the 2.4 billion metric tons of carbon that forests remove from the atmosphere

every year. The entire Amazon stores nearly 100 billion metric tons of carbon—about a decade’s worth of global emissions.

The Amazon hosts anywhere between 15 to 25 per cent of the land-based biodiversity of the planet. It is a source of enormous cultural diversity as well. More than thirty-five million people live in this wondrous place. This includes nearly one million indigenous peoples from around 400 indigenous groups, with their own cultural identities and their valuable traditional knowledge.

In a World Economic Forum report we estimated that the GDP of the ‘extractive economy’ in the Amazon Basin is about \$250 billion per year. While this economic model is mostly responsible for deforestation and forest degradation of the Amazon, it has also led in most Amazonian countries to a reduction of poverty over the last thirty years, albeit with rising inequality leading to generalized social unrest of all countries in the region and a second ‘lost decade’.

The large tracts of the Amazon Basin which are on fire have raised the stakes significantly both in the Amazonian region and across the world given the strategic role that the Amazon Basin plays as home to around half of the world’s remaining tropical forests with significant implications for the global climate and to preserving life on the planet.

This is particularly alarming in the context of the last twelve years.

The Amazon basin experienced megadroughts in 2005 and 2010, and mega floods in 2009 and 2012, each with a probability of occurrence of about one in every 200 years. The occurrence of so many rare and extreme events in such a short time signals a change in the status quo of the natural system. Such oscillations between extremes could propel the collapse of the Amazon biome — up to 60 per cent of the Amazon forest could be transformed into degraded savannahs in the next two to three decades due to a combination of deforestation, forest fires and climate change with catastrophic consequences for South America and for the world at large.

Top climate scientists have recently published a commentary in *Nature* explaining that

we are rapidly approaching ‘a global cascade of tipping points that lead to a new less habitable hothouse climate state’ in part because of the transgression of the Amazon Die Back tipping point that is potentially in progress.

The ‘Amazonian Library of Biological Knowledge’ is quite literally being burned to make space for low productivity cattle ranching to feed meat to the world, imposing a gigantic cost to the global economy for generations to come.

The future of the Amazon and its impact on the planet clearly lie in the balance. An inclusive bioeconomy development paradigm is within reach if we are able to deploy this new model with a ‘new science of progress’ that is fit for purpose to preserve the Amazon and its people.

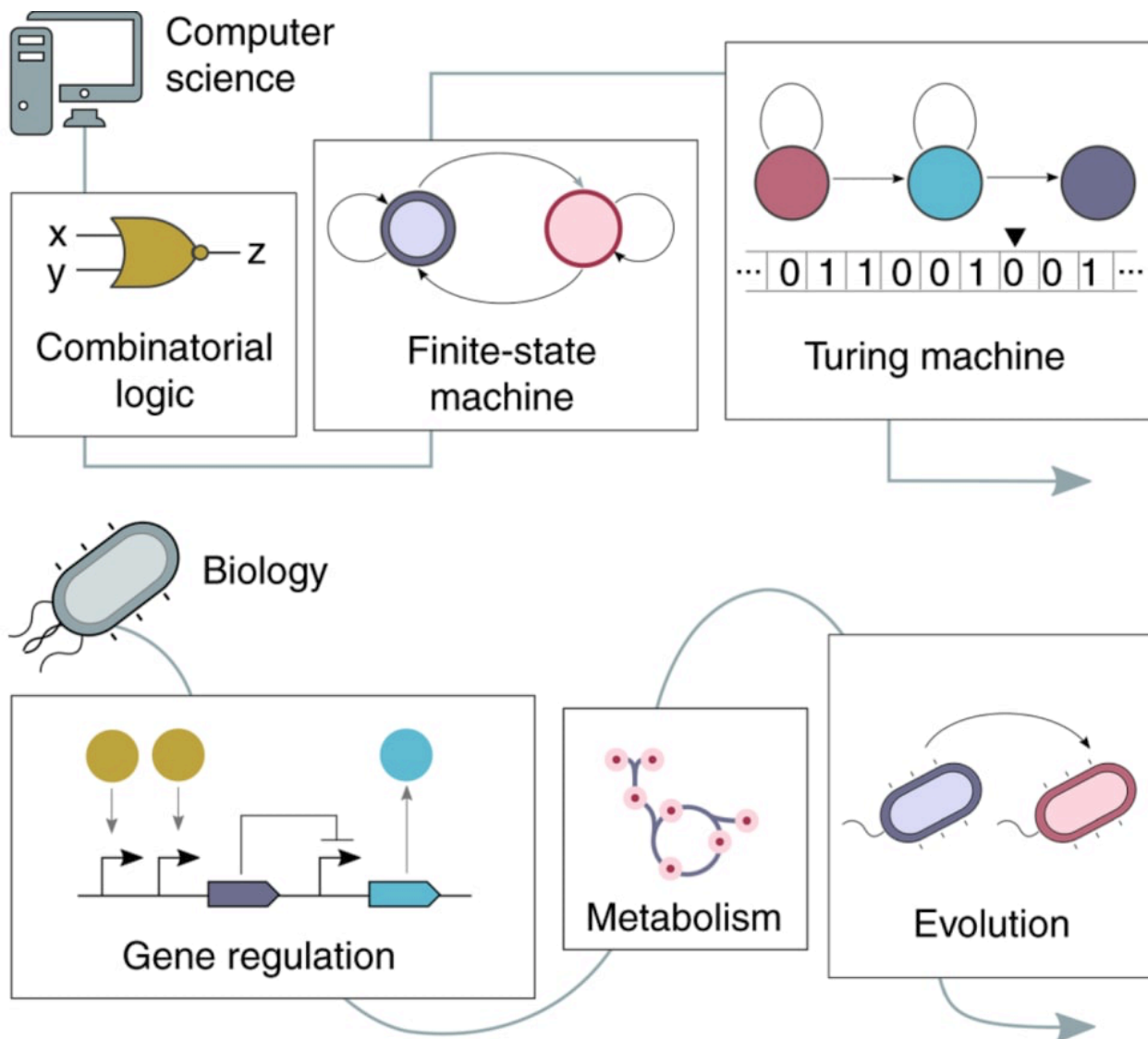
An inclusive bioeconomy model to emerge out of the Book of Life

In ‘On the Origin of Species’, back in 1859, Charles Darwin was the first to produce an evolutionary Tree of Life. What scientists are calling the Book of Life is the modern version of this, decodifying the DNA of all complex species on the planet and their complex relationships.

Now preserving life on the planet in the context of the sixth mass extinction is not only critical to our own survival as a species, but also to preserve Nature’s vast biological intelligence codified in the Book of Life over the last 3.5 billion years of evolution of life on the planet. In addition, over the last 30 years, biology has become fully digital where by biological intelligence is effectively coded as ‘ones and zeros’ in DNA.

In turn, this means that when the book is written, a powerful nature-inspired innovation engine can be unleashed by engineering biology at scale that was described by Oliver Morton’s *The Economist* briefing on synthetic biology, and more recently by the VC firm Andressen Horowitz in its *Biology is Eating the World* manifesto. Whereas synthetic biology uses living cells to perform engineered genetic circuits and computations, Goni-Moreno and colleagues in a *Nature* paper *Pathways to cellular supremacy in biocomputing* propose a computational biology supremacy paradigm analogous to quantum computing.

In addition, Flagship Pioneering in *The Coming Age of Generative Biology*, argues that machine learning will be able to extract the ‘engineering principles from vast biological complexity and generate new molecules, gene and cell therapies, and medicines we have yet to imagine’.



From Pathway to cellular supremacy in biocomputing, showing a comparison between computational processes as understood in computer science and in biology.

We recently argued in *The Financial Times* that to-date, even though biologists have only decoded 0.28 per cent of the Book of Life, this is about to change.

Together with a leading group of scientists, we took advantage of a million-fold decrease in the costs of DNA sequencing since the Human Genome Project was completed in

2003, and launched the Earth BioGenome Project to fully sequence 100 per cent of the complex life on the planet, on land and in the oceans (the eukaryotes), over the next ten years for less than what it costs to sequence our own genome (US\$ 4.8 billion in today's dollars).

This will provide a new foundation for biological discovery and innovation at an unprecedented scale. A case in point is that the Amazon rainforest alone could be a source of up to 20 per cent of urgently needed antimicrobials to combat the most dire public health challenge of the 21st century—antimicrobial drug resistance—with deaths potentially increasing to 10 million per year by 2050, and a drop in global GDP of between 2 to 3.5 per cent — or a loss of up to USD 100 trillion if nothing is done. The Amazonian Kampo Frog (*Phyllomedusa bicolor*) and similar tropical frogs may have the bio-production instruction sets buried in their DNA.

If you think that the surveillance economy based on monetizing people's private experiences will be the most 'valuable' enterprise in the 21st century, think again- it will be Biology. When we reach full sequencing capacity, we will be generating about 1,000-2,000 more data than that produced by Facebook, Twitter, YouTube, combined. Significant advances in artificial intelligence and in causal data science of the type pioneered by Elias Barenboim and Judea Pearl will be needed to decodify the many complex networks at work in the Book of Life.

A new inclusive bioeconomy focused on prosperity for all can help solve the majority of humanity's problems in energy, water, food, materials, healthcare and transport in a rapidly changing climate – this is consistent with Erik Beinhocker's view of rethinking capitalism by refocusing on solving humanity's problems. As Zach Bogue from DCVC put it to me recently: 'It is as if the Life on Planet was a gift of extra-terrestrial civilizations... They gave us their most advanced technologies, but forgot to give us the manuals...'

In addition, this new bioeconomy has the potential to reverse a rapid de-industrialization process in developing economies that are bio-asset rich – and in so doing, provide the basis for a new bio-inspired economic development model that can be in harmony with nature and with the custodians of nature.

However, a critical precondition to write all chapters of the Book of Life is the access to the vast biological assets from bio-diverse nations in the tropics. There are two conflicting goals that we need to resolve: first, the Book of Life should be open for discovery by scientists and innovators globally, and second, fair and equitable commercial benefit from it should be fully traceable and enforceable along the complex genomics information value chain typical of advanced biotechnology (the Nagoya Protocol entered into force in October 2014 to ensure fair sharing of commercial benefits from the access and utilisation of biodiversity.) This is the dual mission of the Earth Bank of Codes that we launched in partnership with the World Economic Forum as a sister initiative to the Earth BioGenome Project.

If we are successful on this journey, global trade rules may potentially be re-written so that the currently invisible nature-inspired assets and services of developing countries in the Tropics are valued properly. This in turn will magnify the competition in the race to control the vast biological intelligence embedded in the Book of Life that will inspire the next generation of artificial intelligence capabilities that will be foundational for global leadership at the heart of geopolitics, trade and technology wars today and in the foreseeable future.

To ensure maximum societal value and public benefit from decoding the Book of Life, we need to proactively engineer the governance on data access, data sharing, and the use of protocols to avoid the vast concentration of wealth and power in a few companies, and to proactively identify and manage the risks and the many unintended consequences that the Book of Life will certainly enable. As a case in point, consider engineering longevity and the social and economic disruptions that it may bring to society at large. I often ask myself if we really know what we are doing, given that Biology may be far too complex for us humans to understand, engineer and control? Flagship Pioneering's Can Machines Understand Complex Biology? attempt to shine some light on this question but much more research is needed, given the major ethical implications at play. Given that we are increasingly dealing with disorganized complexity at exponential speeds in Biology, I believe that we need to go back to Weaver's timeless 1947 paper on Science & Complexity, where he compares simplicity with both organized and disorganized complexity.

We at SpaceTime Ventures are preparing our team entry to the Rainforest X Prize that was recently announced. We are now in process of integrating world class experts and partner institutions to complement us. If you are interested in reaching out to explore a collaboration please reach out to us at contato@spacetimeventures.com.

SOS Climate emergency: 411.86 ppm | 3,813 days

Each week, we're going to remind you of the CO2 levels in the atmosphere and the number of days until reaching the 450ppm threshold.

The latest measurement (as of Dec 18): 411.86ppm; December, 2018: 408.44ppm; 25 years ago: 360ppm; 250 years ago, est: 250ppm. Share this reminder with your community by forwarding this email or [tweeting this](#).

🌍 Appreciating the beauty and the wrath of nature: [a storm system named Hector over the Kiwi Islands](#) looks like a volcanic eruption from space; and fires in Australia from space ([Nov 12th](#) , [Nov 10th](#) and [Dec 5th](#)).

[100](#) Two excellent long reads that I recommend to make sense of the speed of energy transition are WEF's [Speed of the Energy Transition](#) and Rocky Mountain Institute's [Seven Energy Challenges Report](#).

End note

Hey,

We're increasingly making sense of the biological world, understanding how it nourishes and protects us, yet is also a source of inspiration and productivity. I've had several conversations this year with founders in the field of synthetic biology. Juan Carlos outlines the case for understanding natural assets. This (very broad) field is one of the most exciting domains—and one which we will turn to as we most into the post-industrial, environmentally stretched stage of development.

I'll go on my own learning journey next year. Thanks to Juan Carlos for kicking it off this week.

Have a nice Christmas break next week. I'll be back on Sunday.

Azeem 🎅

What you are up to—notes from EV readers

Congratulations to Katherine Bell who's been named the new Editor in Chief at Quartz!

Bobby Healey really wants to deliver you warm burgers.... congrats for raising a \$5.2m seed round for his drone delivery startup, Manna Aero!

Congrats to Libby Kinsey and other readers at Digital Katapult on being awarded the Best Paper award at the NeurIPS Conference AI for Good Workshop!

Claudia Chwalisz talks to Salon about 'citizen assemblies' and deliberative democracy, and what could be the bright spot of politics in the new decade.

Benjamin Welby and his colleagues at OECD have published a new report discussing what governments need to be thinking about in order to become 'data-driven'.

Polly Mackenzie: 'I don't like Boris Johnson. But I want him to succeed.'

Sonia Rehill at Outlier Ventures shared her team's predictions for 2020.

Brett Bivens shares his weekly audio/video program focused on exploring key trends that he thinks about as an early-stage investor.

Dr Michelle Tempest has a new book out about AI and how it impacts our minds.

Congrats to our readers at Hugging Face for raising a \$15m round led by EV readers at Lux Capital.

Jan Erik Solem and our readers at Mapillary reflect back on this passing year.

Dave Goldblatt just launched a micro-podcasting app, [Wavechat](#), that allows you to creatively connect and follow friends through podcast-like stories and private voice messages.

Ella Goldner and her team at Zinc are [looking for fifty talented and driven people passionate about improving mental health](#) to join Zinc’s new Academy programme.

[Davide Casaleggio digs into what smart companies really are.](#)

Dig deeper—previously published by EV

Synthetic biology and genomics:

- [The Rise of Nanotechnology](#)
- [Engineering Biology](#)
- [Should We Sequence Everyone’s Genome?](#)
- [AI and the Genetic Revolution](#)
- [The Future of Longevity](#)

Rethinking capitalism:

- [The Innovation Economy with Mariana Mazzucato](#)
- [Doughnut Economics: Rethinking Economics for the 21st Century](#)

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Simon Darling Dec 22, 2019 Liked by Azeem Azhar

Easy to read and motivating. Good links too. I hadn’t read Andreessen Horowitz biology manifesto. So true.

♥ 18 Reply



Michael Szul Dec 22, 2019

Fantastic issue. ♥ Reply

Top posts

🔮 **Cyberwar; the infrastructure phase; Amazon & AI; Tim's new web; amazing founders; secularization, microbiota & drone killers++ #186**

You might notice a change in this week's newsletter. We are considering transition to a new email platform, and you are part of our test cohort. We wil...

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