

**Pragmatic Sustainability and emerging
technologies: contributions for sustainable
decision-making ¹²**

**Sustentabilidade Pragmática e tecnologias
emergentes: contribuições para a tomada de
decisão sustentável**

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Abstract

The general objective of this article is to outline a concept of Sustainability that can respond to the risks of new technologies typical of the Fourth Industrial Revolution, called Emerging Technologies, without jeopardizing the opportunities they present. As specific objectives, it's sought to present two approaches to Sustainability, top-down and bottom-up, and their relationship with technology in general; next, to describe the Emerging Technologies and the precautionary and promotional principles, linking them to the two approaches to Sustainability, and

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situating the whole in the Brazilian legal scenario; and to present legal pragmatism, and make use of it to read the precautionary principle, in such a way that is able to support a third approach to Sustainability. In final considerations, Pragmatic Sustainability is presented as a contribution to the debate regarding the Sustainability of Emerging Technologies.

Keywords: Emerging Technologies. Legal Pragmatism. Precautionary Principle. Promotional Principle. Sustainability. Sustainable Decision-Making.

Resumo

O objetivo geral deste artigo é delinear um conceito de Sustentabilidade que possa responder aos riscos das novas tecnologias típicas da Quarta Revolução Industrial, denominadas Tecnologias Emergentes, sem comprometer as oportunidades que apresentam. Como objetivos específicos, busca-se apresentar duas abordagens da Sustentabilidade, top-down e bottom-up, e sua relação com a tecnologia em geral. Em seguida, descrevem-se as Tecnologias Emergentes e os princípios da precaução e promoção, relacionando-os com as duas abordagens da Sustentabilidade, e situando o conjunto no cenário jurídico brasileiro. Também se descreve o pragmatismo jurídico e, com base nele, faz-se uso dele para ler o princípio da precaução, de forma que seja capaz de sustentar uma terceira abordagem para a Sustentabilidade. Nas considerações finais, a Sustentabilidade Pragmática é apresentada como uma contribuição ao debate sobre a Sustentabilidade das Tecnologias Emergentes.

Palavras-chave: Pragmatismo Jurídico; Princípio da Precaução. Princípio Promocional. Sustentabilidade. Tomada de decisão sustentável. Tecnologias Emergentes.

Introduction

This article proposes to outline a concept of Sustainability that can respond to the risks of new technologies, typical of the Fourth Industrial Revolution and called Emerging Technologies, without jeopardizing the opportunities that these technologies may offer.

To do so, initially two distinct approaches to the Sustainability phenomenon are identified, among the countless possible ones, calling them top-down and bottom-up; and it's analysed how each of them relates to Emerging Technologies, including the challenges these present.

Next, the accommodation of these two approaches to the Brazilian legal scenario is examined, and, keeping said scenario as a backdrop, the building of a bridge between them is attempted, in order to extract the best of each one, in facing the challenges mentioned.

The hypotheses to be addressed consist of: the possibility of building such a bridge; using legal pragmatism as a building material for that enterprise; and the provision of a reading of the precautionary principle, which allows the emergence of a hybrid vision of Sustainability, called Pragmatic Sustainability.

In order to fulfil its objectives, the research operated with the inductive method in its investigation phase; the analytical method in the data processing phase; and, again, with the inductive method in this report in the form of a scientific article. The supporting techniques were the category, the operational concept, the referent and the bibliographic research⁶.

1. Two views of sustainability, its dimensions and relationship to technology

Sustainability has been increasingly brought forward in the most diverse arenas of public debate, including, among others, the political, legal, educational and journalistic spheres. It nowadays compounds the discourse of varied areas of scientific knowledge, as well. Robert Paehlke affirms that it constitutes a bridging concept, integrating social sciences, natural sciences and philosophy into a wider totality, and points its simultaneous pertinence to, for instance, biology, political science, economics and ethics⁷.

This holistic character of Sustainability, however, does not exempt it from ambiguities, and it should not come as a surprise that arguments centred upon it, and in apparent disagreement, actually deal with entirely different objects⁸.

The overcoming of differences, however, is important for the flourishing and enrichment of any field of study⁹, which is why the building of bridges, in Paehlke's manner, may have an interesting role to play in Sustainability's research.

Among the many distinct possible approaches that present themselves,

⁶ About methods and techniques, see PASOLD, Cesar Luiz. **Metodologia da Pesquisa Jurídica** - Teoria e Prática. 14.ed.rev.atual.amp. Florianópolis: EMais, 2018. p. 89 to 115.

⁷ PAEHLKE, Robert. Sustainability as a Bridging Concept. **Conservation Biology**, Washington DC, v. 19, n. 1, p. 36 a 38, feb. 2005. p. 36.

⁸ About differences and disagreements, see DWORKIN, Ronald. **Justice for Hedgehogs**. Cambridge: Harvard University Press, 2011. p. 130 to 134 and 157 to 188.

⁹ About overcoming differences and sharing the value of interpretation, see DWORKIN, Ronald. **Justice for Hedgehogs**. p. 130 to 131.

in relation to the phenomenon of Sustainability, this article purports to analyse two: top-down and bottom-up - in line with a terminology in vogue in many Emerging Technologies, such as Nanotechnology.¹⁰ Yet, it's relevant to point out that the precision with which these notions are applied here differ a bit from the one found in the technological field, since Law, being interpretive, invites a somewhat more open conceptual texture.

From a top-down perspective, Sustainability consists of a fundamental principle of Law¹¹, as much an integral part of the Constitutional State as the principles of democracy, liberty, rule of law and equal protection¹². It presents, as ethical grounds, the satisfaction of current human needs without compromising the future generations' needs and the natural environment¹³; the inherent value of all life¹⁴; and the dignity and potential of all human beings¹⁵. Its content points to the duty to protect and restore the integrity and substance of Earth's ecological systems¹⁶, keeping natural resources consumption levels lower or equal to the ecosystems' regeneration or recovery capacity¹⁷, so assuring that society may endure for an indefinite time, in conditions that ensure human dignity¹⁸.

¹⁰ See, for instance, the didactic explanation contained in LUTHER, Wolfgang. **Bottom-up Methods for Making Nanotechnology Products**. Available on: <<http://www.azonano.com/details.asp?ArticleID=1079#>>. Access on: jan.11.2021. With more details, SILVA, Guilherme Frederico Bernardo Lenz e. **Nanotecnologia: avaliação e análise dos possíveis impactos à saúde ocupacional e segurança do trabalhador no manuseio, síntese e incorporação de nanomateriais em compósitos refratários de matriz cerâmica**. 2008. Monograph (Specialization in Workplace Safety Engineering) – Federal University of Minas Gerais. p. 10 to 12. Available on: <<https://www.livrosgratis.com.br/ler-livro-online-44091/nanotecnologia--avaliacao-e-analise-dos-possiveis-impactos-a-saude-ocupacional-e-seguranca-do-trabalhador-do-manuseio-sintese-e-incorporacao-de-nanomateriais-em-compositos-refratarios-de-matriz-ceram>>. Access on: jan.11.2021.

¹¹ BOSSELMANN, Klaus. **O princípio da sustentabilidade**. Transformando direito e governança. Phillip Gil França translation. São Paulo: Revista dos Tribunais, 2015. Original title: *The principle of sustainability: transforming law and governance*. p. 89.

¹² CANOTILHO, José Joaquim Gomes. O princípio da sustentabilidade como princípio estruturante do direito constitucional. **Revista de Estudos Politécnicos** - Polytechnical Studies Review, Barcelos, v. III, n. 13, p. 7 to 18, jun. 2010. Available on: <http://www.scielo.mec.pt/scielo.php?script=sci_arttext&pid=S1645-99112010000100002> access on jan.11.2021. p. 7.

¹³ BOSSELMANN, Klaus. **O princípio da sustentabilidade**. p. 27.

¹⁴ BOSSELMANN, Klaus. **O princípio da sustentabilidade**. p. 104 e 109.

¹⁵ BOSSELMANN, Klaus. **O princípio da sustentabilidade**. p. 104.

¹⁶ BOSSELMANN, Klaus. **O princípio da sustentabilidade**. p. 82.

¹⁷ CANOTILHO, José Joaquim Gomes. O princípio da sustentabilidade como princípio estruturante do direito constitucional. p. 7.

¹⁸ CRUZ, Paulo Márcio; FERRER, Gabriel Real. Direito, sustentabilidade e a premissa tecnológica como ampliação de seus fundamentos. **Sequência**, Florianópolis, n. 71, p. 239 to

From a bottom-up perspective, conversely, Sustainability includes all measures that will allow a given community to endure in time and generate economic growth, satisfying its long term needs and providing well-being to its members, within the limits of the natural systems in which it inserts itself, therefore preserving the quality of its environment¹⁹.

Under such prism, it's a so-called generative concept, meaning one that develops and enriches itself in tandem with its application to practical situations, as it incorporates experiments with successful results, encourages new ways of seeing and understanding old problems, explores new tools or enables existing ones to adapt to new circumstances and contexts²⁰.

The top-down vision, on the one hand, is originally legal, but it may incorporate any multidisciplinary, structural and cooperative solutions compatible with its directives, and should be needed to face the global and systemic challenges that present themselves to Humanity²¹. In this sense, Sustainability will have a central role to play in a global legal order, presiding “[...] the intersystemic set of relations that the environment generates with other goods and values, mainly in the social, economic, cultural and technological perspectives”²².

On the other hand, the bottom-up perspective is of multidisciplinary nature, to begin with. Notwithstanding, their proponents advocate that Sustainability, so understood, may become the central premise that animates environmental governance, ascribing, to the latter, a results-based sense of purpose, including in the global sphere²³. For them, Sustainability represents the

278, dec.2015. Available on <<http://dx.doi.org/10.5007/2177-7055.2015v36n71p239>>. Access on jan.11.2021. p. 240.

¹⁹ DURANT, Robert F. Introduction. In: DURANT, Robert F.; FIORINO, Daniel J.; O'LEARY, Rosemary (eds). **Environmental Governance Reconsidered**. Challenges, Choices and Opportunities. 2. ed. Cambridge: The MIT Press, 2017. Kindle Edition. Introduction. KRAFT, Michael. Sustainability and Environmental Policy. In: DURANT, Robert F.; FIORINO, Daniel J.; O'LEARY, Rosemary (eds). **Environmental Governance Reconsidered**. Challenges, Choices and Opportunities. 2. ed. Cambridge: The MIT Press, 2017. Kindle Edition. Chapter 2.

²⁰ DURANT, Robert F. Introduction; KRAFT, Michael. Sustainability and Environmental Policy. The latter presents a detailed review of the experiments of several US cities, which had the goal of becoming sustainable.

²¹ FREITAS, Juarez de. **Sustentabilidade**. Direito ao futuro. Belo Horizonte: Forum, 2016. p. 53.

²² Authors' translation from the original: “[...] o conjunto intersistêmico de relações que o ambiente gera com outros bens e valores, principalmente nas perspectivas sociais, econômicas, culturais e tecnológicas”. See CRUZ, Paulo Márcio; FERRER, Gabriel Real. Direito, sustentabilidade e a premissa tecnológica como ampliação de seus fundamentos. p. 250 to 251.

²³ DURANT, Robert F. Introduction.

third and current generation of environmental governance, joining the ones that preceded it, centred, respectively, in regulation and market-based instruments²⁴. Through that path, one may visualize its incorporation to Law, since regulatory actions and economic incentives of environmental nature, in the most diverse settings, gradually come to embody Sustainability's directives.

Both conceptions are multidimensional. For Paulo Márcio Cruz and Gabriel Real Ferrer²⁵, adept of the top-down view, the so-called classic dimensions of Sustainability are three: environmental, concerning the preservation of the complex processes which allow life to endure on the planet, through the decrease of human pressure on ecosystems; economic, related to the increase of environmentally sustainable generation of wealth and its equitable distribution; and social, about the guarantee of dignity and life quality to everyone. It can be noticed that the three dimensions are mainly grounded in values.

For Robert F. Durant, Daniel Fiorino, Rosemary O'Leary and Michael Kraft, proponents of a bottom-up approach, Sustainability creates the so called triple bottom-line, in the sense that economic growth's benefits should not be sought in an unbridled way, without concerns regarding environmental quality and social justice²⁶.

The expression bottom-line comes originally from the realms of management and business administration and means the final gains and losses results obtained by a given enterprise in a set period, usually in financial terms²⁷. Its triplication implies aggregating the social and environmental results to the balance sheet as well, an idea that overflowed from businesses to encompass communities, cities, states, countries, and global governance. Thus, it can be noticed that, in this line, the three dimensions are primarily results-based.

There are also differences, in the way each conception views

²⁴ DURANT, Robert F. Introduction.

²⁵ CRUZ, Paulo Márcio; FERRER, Gabriel Real. Direito, sustentabilidade e a premissa tecnológica como ampliação de seus fundamentos. p. 243 to 250.

²⁶ DURANT, Robert F. Introduction; e DURANT, Robert F.; FIORINO, Daniel J.; O'LEARY, Rosemary. Reconceptualizing Purpose. In: DURANT, Robert F.; FIORINO, Daniel J.; O'LEARY, Rosemary (eds). **Environmental Governance Reconsidered**. Challenges, Choices and Opportunities. 2. ed. Cambridge: The MIT Press, 2017. Kindle Edition. Section I.

²⁷ BOTTOM LINE. **Cambridge Dictionary**. Available on <<https://dictionary.cambridge.org/us/dictionary/english/bottom-line>>. Access on: jan.11.2021.

technological evolution. Technology consists on the set of means developed by human beings, to improve their conditions of existence²⁸. Although it is not a recent phenomenon, since even the oldest configurations of the species' social formations modified, for such purpose, parts of the environment in which they lived²⁹; its use, in order to extract the maximum utility of nature, is linked to the characteristic ideology of the modern age, *i.e.* human domination over the natural environment and his own destiny³⁰.

Cruz and Ferrer point out that the exacerbation of this claim, throughout modernity and, especially, in its present phase, provoked the development of technologies capable of engendering globally catastrophic risks, and thus extinguishing the very society that allowed and favoured its development³¹.

According to them, each of the three classic dimensions of Sustainability responds to risks that can put an end to the civilizing progress of human society; and, precisely because of this, it's necessary to recognize the existence of an additional dimension: the technological one³².

Thus, technology is seen mainly from the point of view of the risks it entails, and the need for its control to promote Sustainability's other dimensions. This understanding is compatible with the top-down approach of Sustainability.

On the other hand, Daniel J. Fiorino points out that technology provides the most efficient use of materials and energy, reducing production costs and increasing its value³³. He proposes that any environmental regulation should be planned, so as not to hinder the development of new technologies; avoiding prescriptive policies regarding technological standards to be adopted by agents,

²⁸ DERANI, Cristiane. **Direito ambiental econômico**. 3. ed. São Paulo: Saraiva, 2008. p. 162.

²⁹ RIFKIN, Jeremy. **La civilización empática**. La carrera hacia una conciencia global en un mundo en crisis. Genís Sánchez Barberán and Vanesa Casanova translation. Barcelona: Paidós, 2010. Original title: *The Empatic Civilization. The Race to Global Consciousness in a World in Crisis*. p. 31 and 32.

³⁰ DERANI, Cristiane. **Direito ambiental econômico**. p. 166.

³¹ CRUZ, Paulo Márcio; FERRER, Gabriel Real. *Direito, sustentabilidade e a premissa tecnológica como ampliação de seus fundamentos*. p. 263.

³² CRUZ, Paulo Márcio; FERRER, Gabriel Real. *Direito, sustentabilidade e a premissa tecnológica como ampliação de seus fundamentos*. p. 263 to 264.

³³ FIORINO, Daniel J. *Regulatory Innovation and Change*. In: DURANT, Robert F.; FIORINO, Daniel J.; O'LEARY, Rosemary (eds). **Environmental Governance Reconsidered**. Challenges, Choices and Opportunities. 2. ed. Cambridge: The MIT Press, 2017. Kindle Edition. Chapter 9.

and thus providing them flexibility to use the methods necessary to comply³⁴. Jennifer Kuzma goes further, and suggests that environmental regulations should, as one of their objectives, stimulate the creation and development of new technologies, which would enable agents to achieve the goals set by environmental policies³⁵.

Thus, technology stands out for the opportunities it provides, especially for the sustainable results that it is likely to produce; a vision that conforms to a bottom-up conception of Sustainability.

It remains to ponder on the possibilities that these two conceptions present, in relation to Emerging Technologies.

2. Emerging technologies, precaution and promotion

Although the relationship between Sustainability and technology is not new, both under the perspective of the risks it presents and its respective opportunities; it is necessary to recognize that, since the end of the last century, the scope of innovations in this field, both from a quantitative and a qualitative point of view, as well as their dissemination in the most widespread areas of society, invite a different reflection.

Klaus Schwab³⁶ emphasizes the close connection and interaction between the changes, arising from the application of technological innovations to the production processes, which occurred in the aforementioned period, and the reconfiguration of social relations, in a context which he calls the “Fourth Industrial Revolution”. The author³⁷ mentions, as examples of the technological innovations embedded in the context of the revolution he describes, artificial intelligence, robotics, the internet of things, autonomous vehicles, 3D printing, nanotechnology, biotechnology, and quantum computing; all evolving in a convergent way, building and amplifying each other.

³⁴ FIORINO, Daniel J. Regulatory Innovation and Change.

³⁵ KUZMA, Jennifer. Risk, Environmental Governance and Emerging Biotechnology. *In*: DURANT, Robert F.; FIORINO, Daniel J.; O’LEARY, Rosemary (eds). **Environmental Governance Reconsidered**. Challenges, Choices and Opportunities. 2. ed. Cambridge: The MIT Press, 2017. Kindle Edition. Chapter 7.

³⁶ SCHWAB, Klaus. **A quarta revolução industrial**. Daniel Moreira Miranda translation. São Paulo: Edipro, 2016. Original title: The fourth industrial revolution. p. 12 and 13.

³⁷ SCHWAB, Klaus. **A quarta revolução industrial**. p. 12 and 13.

Fabiano Hartmann Peixoto and Roberta Zumblick Martins da Silva point out that these innovations consist of a comprehensive movement, encompassing several areas of knowledge and aiming to act on the great challenges of society³⁸.

It is proposed here to use Kuzma's³⁹ designation to the technologies developed in this revolutionary context, distinct from traditional technologies: Emerging Technologies.

According to the author⁴⁰, these are defined as “[...] recent, enabling technologies that can be used in various contexts for multiple purposes and have the potential to disrupt social or natural systems”. Kuzma⁴¹ adds that they involve knowledge deficits in relation to their impacts on human health, the environment, social organization, and culture; and, therefore, decisions about them are made in a context of great uncertainty.

As can be seen, the disruptive aspects touch all Sustainability's dimensions, economic, social, and environmental, whatever the prism under which there are seen. However, one can distinguish responses on two distinct bases.

One of them is precautionary. The precautionary principle demands a cautious conduct, prior to the manifestation of danger, and aims to establish a space-time security perimeter, in relation to such manifestation⁴². According to Teresa Ancona Lopez, it requires the taking of drastic and effective measures in order to anticipate the supposed and possible risk, even in the face of uncertainty⁴³.

Such principle has been considered an integral part of Sustainability, viewed under a top-down perspective. Delton Winter de Carvalho⁴⁴, for example, affirms that despite the uncertainties regarding the future consequences of

³⁸ PEIXOTO, Fabiano Hartmann; SILVA, Roberta Zumblick Martins da. **Inteligência Artificial e Direito**. Volume I. Curitiba: Alteridade, 2019. p. 50.

³⁹ KUZMA, Jennifer. Risk, Environmental Governance and Emerging Biotechnology.

⁴⁰ KUZMA, Jennifer. Risk, Environmental Governance and Emerging Biotechnology.

⁴¹ KUZMA, Jennifer. Risk, Environmental Governance and Emerging Biotechnology.

⁴² DERANI, Cristiane. **Direito ambiental econômico**. p. 150.

⁴³ LOPEZ, Teresa Ancona. **Princípio da precaução e evolução da responsabilidade civil**. São Paulo: Quartier Latin, 2010. p. 103.

⁴⁴ CARVALHO, Délton Winter de. **Dano ambiental futuro**. A responsabilização civil pelo risco ambiental. 2. ed. rev. atual. e amp. Porto Alegre: Livraria do Advogado, 2013. p. 198.

certain activities, the legal norm cannot abstain from guaranteeing the right of future generations to the environmental conditions and quality necessary for a worthy subsistence. Note that, while the need to adopt measures to avoid environmental damage, even in uncertain scenarios, is of the essence of precaution; the preservation of environmental quality, in order to guarantee the supply of future generations' needs, is the guiding idea of top-down Sustainability, as explained in item 1.

The other response is promotional, and it can be best illustrated as a full inversion of the precautionary one. In this sense, Kuzma argues that the promotional principle implies considering a given technology as harmless, until possible damage is proven, and in the tendency to accept "false negatives", instead of "false positives". This principle points to the restrictive interpretation of damage indicators, and to the approval of an activity, if there are doubts about its safety⁴⁵.

Such an approach is in line with the understanding of technology and its results as of a mainly beneficial nature and corresponds to a bottom-up vision of Sustainability. Kuzma⁴⁶ asserts that the promotional approach prevails in the United States of America and exemplifies it with a detailed study of genetically modified organisms' (GMOs) regulation in the country. She points out that one of the principles of this area of Emerging Technologies states that the objects of regulation must be the products obtained with the technology, and not the processes of obtaining them; thus, demonstrating the emphasis on results regarding the promotional response to the uncertainties engendered by new technologies.

Also from this area comes the wide range of criticisms that the author formulated and collected in the literature, regarding the insufficiency of the promotional principle as a response to concerns caused by GMOs, such as indications of allergenicity, toxicity and disruption of ecosystems⁴⁷.

⁴⁵ KUZMA, Jennifer. Risk, Environmental Governance and Emerging Biotechnology.

⁴⁶ KUZMA, Jennifer. Risk, Environmental Governance and Emerging Biotechnology.

⁴⁷ KUZMA, Jennifer. Risk, Environmental Governance and Emerging Biotechnology.

Some ambivalence regarding new technologies can also be seen in the position of Fiorino⁴⁸, who recognizes the need to set strict objectives for environmental policies. He affirms that flexible regulations as to means, but severe as to ends, correspond to high rates of environmental performances⁴⁹. Thus, when admitting the importance of high environmental standards, the risks of technological innovation are not completely lost of sight, and at least some checks are imposed on the most dangerous ones.

Kuzma⁵⁰ criticizes the distinction between products and processes, since, according to her, it doesn't have a scientific basis, and it's crucial to discern the greatest factors of concern regarding risks involving either one or the other.

Another characteristic of Emerging Technologies is their ability to interact with natural systems in complex and unknown ways, and thus to cause irreversible changes in ecosystems⁵¹. As Maria-Angéle Hermitte⁵² affirms, the dangers are barely perceptible by the senses and come from the articulation of several causes, which increases anguish, as it creates a kingdom of shadows. She adds⁵³ that this is particularly true regarding radioactivity, biotechnologies and nanotechnologies, for instance.

These complex and potentially irreversible interactions certainly testify against the Emerging Technologies' promotional stance, focused on specific and limited indicators of possible damage, all examined from a restrictive perspective and with an approval bias.

⁴⁸ FIORINO, Daniel J. Regulatory Innovation and Change.

⁴⁹ FIORINO, Daniel J. Regulatory Innovation and Change.

⁵⁰ FIORINO, Daniel J. Regulatory Innovation and Change. Similarly, PORTO, Marcelo Firpo. Riscos, incertezas e vulnerabilidades: transgênicos e os desafios para a ciência e a governança. **Revista Política e Sociedade**, Florianópolis, v. 4, n. 7, p. 77 to 103, out.2005. p. 92. Available on < <https://periodicos.ufsc.br/index.php/politica/article/download/1966/1717>>. Access on: jan.11.2021.

⁵¹ FIORINO, Daniel J. Regulatory Innovation and Change.

⁵² HERMITTE, Marie-Angéle. A fundação jurídica de uma sociedade das ciências e das técnicas através das crises e dos riscos. In: VARELLA, Marcelo Dias (org). **Direito, sociedade e riscos: a sociedade contemporânea vista a partir da ideia de risco**. Brasília: UniCEUB, 2006, p. 7 to 29. p. 8.

⁵³ HERMITTE, Marie-Angéle. A fundação jurídica de uma sociedade das ciências e das técnicas através das crises e dos riscos.

The Brazilian system, for its part, clearly embraces top-down Sustainability, centred on precaution. Juarez de Freitas⁵⁴ believes that Sustainability is part of the Brazilian constitutional order as an implicit principle, along the lines of the provision contained in article 5, paragraph 2 of the 1988 Charter; and that precaution, in turn, is an integral part of Sustainability.

Cristiane Derani also emphasizes the close link between precaution and Sustainability of human activities, because, for her, economic practices will only be sustainable if there is a careful appropriation of environmental resources, and the avoidance of danger is linked to the safety of future generations⁵⁵.

The precautionary principle is also explicitly stated in several international treaties of which Brazil is a party. Examples are the Convention on Biological Diversity⁵⁶, the United Nations Framework Convention on Climate Change⁵⁷, and the Cartagena Protocol on Biosafety⁵⁸. Several Brazilian ordinary statutes also expressly incorporate it, such as, for example, article 1 of statute 11.105/05 (Biosafety Law)⁵⁹, and Article 6, I of statute 12.305/2010 (National Policy on Solid Waste)⁶⁰. Its guidelines are also spread throughout many other legislative manifestations, despite the absence of an express mention of the

⁵⁴ FREITAS, Juarez de. **Sustentabilidade**. p. 52 and 53; LOPEZ, Teresa Ancona. **Princípio da precaução e evolução da responsabilidade civil**. p. 229.

⁵⁵ DERANI, Cristiane. **Direito ambiental econômico**. p. 151 and 152.

⁵⁶ THE UNITED NATIONS. **Convention on Biological Diversity** (1992). Available on: <<https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=2&ved=2ahUKEwja26Ti kNznAhU4HLkGHQWxBmwQFjABegQIAxAB&url=https%3A%2F%2Fwww.cbd.int%2Fdoc%2Flegal%2Fcbd-en.pdf&usg=AOvVaw0Qz6d9-4rfVn0CvzOKNEpg>>. Access on jan.11.2021.

⁵⁷ THE UNITED NATIONS. **Framework Convention on Climate Change** (1992). Available on <https://unfccc.int/files/essential_background/background_publications_htmlpdf/application/pdf/conveng.pdf> access on jan.11.2021. For internalization in the Brazilian legal system, see BRASIL. **Decreto 2519** (1998). Available on: <http://www.planalto.gov.br/ccivil_03/decreto/D2519.htm>. Access on jan.11.2021.

⁵⁸ THE UNITED NATIONS. **Cartagena Protocol on Biosafety to the Convention on Biological Diversity**. (2000). Available on: <<https://bch.cbd.int/protocol/text/>>. Access on: jan.11.2021. For internalization, see BRASIL. **Decreto 5705** (2006). Available on: <http://www.planalto.gov.br/ccivil_03/_Ato2004-2006/2006/Decreto/D5705.htm>. Access on: jan.11.2021.

⁵⁹ BRASIL. **Lei 11.105** (2005). Available on: <http://www.planalto.gov.br/ccivil_03/_Ato2004-2006/2005/Lei/L11105.htm>. Access on: jan.11.2021.

⁶⁰ BRASIL. **Lei 12.305** (2010). Available on: <http://www.planalto.gov.br/ccivil_03/_ato2007-2010/2010/lei/l12305.htm>. Access on: jan.11.2021.

principle. That is the case of the Consumer Protection Code, the National Environmental Policy and the National Protection and Civil Defence Policy⁶¹.

However, top-down Sustainability, built on a precautionary basis, is not free of ambivalence. Cruz and Ferrer acknowledge that technology can offer cleaner energy models, with less waste; as well as its wealth generation potential, through the provision of new business opportunities and greater productivity in the existing ones⁶². The new technologies also expand human capacity to assess the polluting character of some practices⁶³.

The precautionary principle, for its part, can also be a subject of criticism. For Freitas⁶⁴, for example, a precautionary frenzy might delay vital work for the supply of renewable energies; which shows that the excess of caution, supposedly in the name of Sustainability, can be as harmful as the lack of it.

The criticisms of Cass Sunstein⁶⁵ are also harsh, as he calls into question the performance of any relevant role by the precautionary principle, in the legal systems that welcomed it. According to him⁶⁶, a strong view of the principle - namely, the bringing to bear of its commands from a very low threshold, *i.e.* one of minimal scientific plausibility regarding the advent of serious consequences for a given choice - results in paralysis, by inhibiting all possible courses of action, and even inaction.

Those relevant points notwithstanding, it is to be recognized that there is no basis for replacing the precautionary principle with the promotional one in the Brazilian legal scenario, even though the latter presents better conditions to stimulate technological development. This would not even be advisable, even if

⁶¹ In this sense, see FERREIRA, Keila Pacheco. **Responsabilidade Civil Preventiva**. Função, Pressupostos e Aplicabilidade. 2014. Thesis (SJD) – University of São Paulo. Available on: <<https://www.teses.usp.br/teses/disponiveis/2/2131/tde-27102016-092601/pt-br.php>>. Access on: jan.11.2021. p. 86, 87 and 89.

⁶² CRUZ, Paulo Márcio; FERRER, Gabriel Real. Direito, sustentabilidade e a premissa tecnológica como ampliação de seus fundamentos. p. 259 to 261.

⁶³ DERANI, Cristiane. **Direito ambiental econômico**. p. 168.

⁶⁴ FREITAS, Juarez de. **Sustentabilidade**. p. 164.

⁶⁵ SUNSTEIN, Cass. **Beyond the precautionary principle**. University of Chicago Law & Economics Online Working Paper n. 149. Available on: <https://papers.ssrn.com/sol3/Delivery.cfm/SSRN_ID307098_code020502530.pdf?abstractid=307098&mirid=1>. Access on: jan.11.2021. p. 3 to 21.

⁶⁶ SUNSTEIN, Cass. **Beyond the precautionary principle**. p. 3 to 21.

the Constitution and international treaties allowed it, given the growing disapproval faced by the promotional principle where it is adopted.

However, it is worth reflecting on whether it would be possible, based on the precautionary principle and top-down sustainability, to establish a bridge towards bottom-up sustainability and the promotional principle, so as to take advantage of the latter without detracting from the former. This will be discussed in the next topic.

3. Building a bridge

As can be seen from the above exposition, the two views of Sustainability hereby brought forward retain some degree of ambivalence in relation to technology. Both recognize, albeit with different weights, what Kuzma calls is “[...] perils and promise”⁶⁷. Ambivalence builds precisely upon the dimensions of Sustainability, economic, environmental and social, involving values and results, and revolves around precaution and promotion.

A bridge between these two views may use, as pillars, the aforementioned dimensions. However, with which kind of bricks and mortar might be used as building materials?

Legal pragmatism offers a possibility. According to Richard Posner, legal pragmatism is an offshoot from everyday pragmatism (which differs from philosophical pragmatism), and consists of a disposition to base choices empirically, on facts and consequences, rather than abstractly, on general concepts⁶⁸. The author states that such pragmatism presupposes the absence of high moral principles, which would serve as a guide for decisions in the political and legal fields; and that such decisions should be criticized only on the basis of defective fact findings or bad consequences, but not on objective moral truths⁶⁹.

A priori, this conception may appear to be in line with the bottom-up view of Sustainability, since pragmatism values experimentation⁷⁰. It may seem

⁶⁷ KUZMA, Jennifer. Risk, Environmental Governance and Emerging Biotechnology.

⁶⁸ POSNER, Richard. **Law, Pragmatism and Democracy**. Cambridge: Harvard University Press, 2003. p. 1 to 13 and 49 to 56.

⁶⁹ POSNER, Richard. **Law, Pragmatism and Democracy**. p. 1 a 13 and 49 to 56.

⁷⁰ POSNER, Richard. **Law, Pragmatism and Democracy**. p. 9.

difficult to accommodate legal pragmatism to a concept of Sustainability as loaded with values as the one here called top-down, based on precaution.

As Posner himself explains, though, not only the probable consequences which are peculiar, specific to the situation at hand, should be considered in pragmatic adjudication; but, also, the wider, systemic ones⁷¹. Those include the preservation of values embodied in the legal norms, the provision and reassurance of legal certainty, and the protection of the community's expectations and trust, which are expressed in the principles emerging from the constitutional and statutory texts and case law precedents⁷². There should be recognized that there are undeniable benefits in "[...] simplifying inquiry, minimizing judicial discretion, increasing the transparency of law, and making legal obligation more definite" ⁷³.

It turns out that indeterminacy, ambiguity, indefiniteness and the absence of clear guiding purposes are not exceptional in Law, so that the assessment of probable systemic consequences alone will not be enough to support a judgement⁷⁴.

It should be remembered that, in the case of Emerging Technologies, a too stringent understanding of the precautionary principle may hinder the development of innovative tools, capable of generating positive impacts on the three dimensions of Sustainability, something that doesn't happen with the promotional principle. Ambiguity is the rule here, and not the exception.

Although Brazilian constitutional commandments, along with those of several international treaties of which the country is a party, exclude a *tout court* application of the promotional principle, due to the irreversible damages that could be inflicted to protected legal assets; a pragmatic reading of the precautionary principle itself might be forthcoming, since Emerging Technologies can advance values dear to the Brazilian legal system, such as environmental protection and poverty eradication.

Moreover, as noted by Mauricio de Carvalho Goes and Wilson

⁷¹ POSNER, Richard. **Law, Pragmatism and Democracy**. p. 60 to 80.

⁷² POSNER, Richard. **Law, Pragmatism and Democracy**. p. 60 to 80.

⁷³ POSNER, Richard. **Law, Pragmatism and Democracy**. p. 69.

⁷⁴ POSNER, Richard. **Law, Pragmatism and Democracy**. p. 68.

Engelmann – in a discussion about nanotechnology, but the ideas of which may suit other Emerging Technologies – there's a mismatch between these technologies' evolution, which is fast, and Law's, that tends to a greater gradualism and slowness⁷⁵.

Pragmatism can solve this imbalance, by providing an opening to diverse sources of knowledge, and to their incorporation into the Law.

After all, for legal pragmatism, any important issue can be used to support decision-making, and precisely this opening provides room for creativity, *pari passu* with continuity⁷⁶.

It should be noted that, according to Posner, pragmatic adjudication shows an empiricist orientation, "[...] open to invasions of law from other provinces of thought [...]"⁷⁷. Based on the thoughts of Brian Leiter, Posner incorporates, into legal pragmatism, the view of a naturalized jurisprudence, so eschewing armchair conceptual analyses and encompassing a continuum with natural sciences' inquiries⁷⁸.

In the same vein, Orlando Zanon Junior states that legal decision-making activity must resort to multidisciplinary factual elements "[...] to investigate the causes and effects of the creation of behavioural patterns and their respective impact on the decision-making enterprise in the human communities"⁷⁹.

Although legal pragmatism is not intended to expand the general utility of society, and so it is not to be confused with utilitarianism; achieving a global increase in well-being may well be one of the consequences envisaged in pragmatic adjudication. The real and potential benefits of Emerging Technologies, as well as their social utility, should be taken into the account when deciding on them⁸⁰.

⁷⁵ GOES, Maurício de Carvalho; ENGELMANN, Wilson. **Direito das nanotecnologias e o meio ambiente do trabalho**. Porto Alegre: Livraria do Advogado, 2015. p. 162, 182 and 183.

⁷⁶ POSNER, Richard. **Law, Pragmatism and Democracy**. p. 13, 64 and 65.

⁷⁷ POSNER, Richard. **Law, Pragmatism and Democracy**. p. 75.

⁷⁸ POSNER, Richard. **Law, Pragmatism and Democracy**. p. 77.

⁷⁹ "[...] para investigar as causas e os efeitos da atividade de criação de padrões de comportamento e seu respectivo impacto no empreendimento de tomada de decisões nas coletividades humanas". Author's translation. See ZANON JÚNIOR, Orlando Luiz. **Teoria Complexa do Direito**. 3. ed. rev. e amp. São Paulo: Tirant lo Blanch, 2019. p. 47.

⁸⁰ POSNER, Richard. **Law, Pragmatism and Democracy**. p. 64 and 65.

The key, it should once again be stressed, is a pragmatic reading of the precautionary principle, in a way that it's made to show a facet attuned to the probable and effective consequences of the decisions based on it.

Several authors already conceive the principle in this fashion, although none has called it pragmatic.

Lopez, for example, admits the impossibility of fully eliminating risks, considering it an unattainable utopia⁸¹. Pragmatically, she⁸² states that completely precluding new ventures and technologies would block innovations, sow panic and curb social and economic development; proposing instead that the enforcement of the precautionary principle be examined in the context of time and place, in the light of scientific, political, economic, ethical and statistical sources.

Along the same lines, it's possible to highlight the understanding of Maria Isabel Troncoso⁸³, for whom the precautionary principle imposes the duty to prevent the realization of certain risks, but not a unique way of acting towards that goal. On the contrary, it commands the consideration of the situation's specific circumstances, such as scientific information, existing preventive measures and the nature of suspected risks, balancing the elimination of the risk and the restriction on the activity from which it originates with its benefits, all under a criterion of proportionality⁸⁴.

Carvalho also proposes sensitizing the Law "[...] to the available scientific and technical data, to the advantages and burdens resulting or not from the imposition of preventive measures, as well as to consider the economic and social development involved"⁸⁵.

⁸¹ LOPEZ, Teresa Ancona. **Princípio da precaução e evolução da responsabilidade civil**. São Paulo: Quartier Latin, 2010. p. 31, 95 e 96.

⁸² LOPEZ, Teresa Ancona. **Princípio da precaução e evolução da responsabilidade civil**. p. 31, 95, 96 and 128.

⁸³ TRONCOSO, María Isabel. El principio de precaución y la responsabilidad civil. **Revista de Derecho Privado**, Bogotá, n. 18, p. 205 a 220, 2010. p. 210 and 218.

⁸⁴ TRONCOSO, María Isabel. El principio de precaución y la responsabilidad civil. p. 210 and 218.

⁸⁵ "[...] aos dados científicos e técnicos disponíveis, às vantagens e ônus decorrentes ou não da imposição das medidas preventivas, bem como a levar em consideração o desenvolvimento econômico e social envolvido". Authors's translation. See CARVALHO, Délton Winter de. **Dano ambiental futuro**. p. 232 and 239.

For Phillippe Kourilsky and Geneviève Viney⁸⁶, the precautionary principle cannot mean neither inaction nor infinite deliberations, but a way of acting in situations in which a decision must be taken. They⁸⁷ propose that the precautionary judgements incorporate technical, political and social debates about its object, and, furthermore, an active stance, with the creation of research programs allowing a continuous reassessment of the positions adopted.

This active stance is also an integral part of the precautionary principle in the view of Margaret Stebbing⁸⁸, for whom it requires efforts to mitigate potential losses detected in technical assessments. More than envisioning consequences, therefore, this view of precaution orders to act on them, changing the potential results, and so taking advantage of the opportunities offered by technology.

Goes and Engelmann provide an interesting example of this perspective, when dealing with occupational safety in the use of nanotechnology.

These authors⁸⁹ propose to ground adjudication on information from different sources in dialogue, including, of course, legal texts and precedent, but, also, what they call non-traditional sources. These latter include directives emanating from regulatory bodies, national or otherwise (such as EU-OSHA and NIOSH, for example), from international organizations such as ISO, and perspectives contained in scientific works and experiments conducted in teaching and research institutions⁹⁰. Such instances are more intensely in tune with technical and scientific developments, literature and cutting-edge research, and, therefore, able to provide knowledge for a more effective application of the Law in these matters⁹¹.

⁸⁶ KOURILSKY, Phillippe; VINEY, Geneviève. **Le Principe de Précaution**. Rapport au Premier Ministre. Paris, 1999. Available on: <<https://www.vie-publique.fr/sites/default/files/rapport/pdf/004000402.pdf>>. Access on jan.11.2021. p. 11.

⁸⁷ KOURILSKY, Phillippe; VINEY, Geneviève. **Le Principe de Précaution**. p. 14, 41, 42, 95 e 96.

⁸⁸ STEBBING, Margaret. Avoiding the trust deficit: public engagement, values, the precautionary principle and the future of nanotechnology. **Bioethical Inquiry**, Sydney, v. 6, n. 1, p. 37 a 48, mar. 2009. p. 37 to 48. Available on: <http://www.academia.edu/attachments/48727676/download_file?st=MTU0MjExMzU0MSwyMDAuMTQyLjMuMjQ1&s=swp-splash-paper-cover>. Access on: jan.11.2021. p. 42.

⁸⁹ GOES, Maurício de Carvalho; ENGELMANN, Wilson. **Direito das nanotecnologias e o meio ambiente do trabalho**. p. 172 a 204.

⁹⁰ GOES, Maurício de Carvalho; ENGELMANN, Wilson. **Direito das nanotecnologias e o meio ambiente do trabalho**. p. 172 to 204.

⁹¹ GOES, Maurício de Carvalho; ENGELMANN, Wilson. **Direito das nanotecnologias e o meio ambiente do trabalho**. p. 172 to 204.

According to them⁹², legal decision-making in this way begins with a pre-comprehension of the facts involved; followed by the identification of the constitutional principles which must integrate the legal response to be presented, such as human dignity and the social value of work; and the subsequent hearing of “voices” from other applicable sources, including non-traditional ones. This is a circular movement, so that the adjudicator returns to her pre-comprehension and reconsiders it, based on the new knowledge acquired with the various sources in dialogue, inserting all in her legal reasoning⁹³.

This approach, based on successful results obtained elsewhere and intensely empirical, revolves around constitutional values, and has the precautionary principle as its organizing force⁹⁴.

Thus, it can be considered a model for sustainable decision-making, in general (not only legal decision-making), regarding Emerging Technologies, as it seeks to ensure their safety, without curbing its evolution.

Final considerations

The Sustainability of Emerging Technologies, in the Brazilian legal scenario, may (and should) continue to be the specification of a structuring principle of the constitutional state, based on precaution, which, in turn, points to the early adoption of measures to face risks, even in the face of uncertainty.

However, its construing, presided over by these values, must be open to the factual consequences of its application to problems involving such technologies, to interdisciplinary scientific knowledge, to the results and experiences that can be studied, shared, used and adapted to the context and the scale on which a judgement is necessary.

The Sustainability of Emerging Technologies can be a Pragmatic Sustainability.

⁹² GOES, Maurício de Carvalho; ENGELMANN, Wilson. **Direito das nanotecnologias e o meio ambiente do trabalho**. p. 172 to 204.

⁹³ GOES, Maurício de Carvalho; ENGELMANN, Wilson. **Direito das nanotecnologias e o meio ambiente do trabalho**. p. 172 to 204.

⁹⁴ GOES, Maurício de Carvalho; ENGELMANN, Wilson. **Direito das nanotecnologias e o meio ambiente do trabalho**. p. 172 to 204.

It calls for a top-down pre-comprehension, however subject to a bottom-up re-elaboration, based on an expansion of the decision-making bases, able to illuminate the consequences and results of each course of action; and, thus, result in the best possible choice, in relation to all its dimensions, environmental, economic and social. Using the words of Zanon, it is a multi-reflective and multidirectional concatenation of sources⁹⁵, oriented both by values and results. Aqui deverá ser colocada a introdução utilizando esta exata formatação.

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⁹⁵ ZANON JÚNIOR, Orlando Luiz. **Teoria Complexa do Direito**. p. 102.

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