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Science, Technology, Society, and Law

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Chapter 1
Science, Technology, Society, and Law

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Over the years, numerous studies and publications have examined the influence of civic and political values on science and technology, emphasizing their inherent social dimensions and society's role in their production.[1] Science examines the laws of nature. In contrast, technology uses more tangible scientific knowledge, resulting in the creation of new things, machinery, and inventions. Scientific research is crucial for technological development and vice versa; technology is essential for the creation of new research instruments.[2] Science contributes to technology in various ways, encompassing its role as a source of innovations; a catalyst for developing new engineering tools and techniques; an enhancer of human skills and, as a tool to assess and evaluate the impact of technology on society. Technology also contributes to science by bringing new scientific challenges as well as new and better measurement of scientific procedures and designs.[3] Views on the relevance of science and technology range from those seeing it as a net positive contributor to societal development to those concerned about its potentially negative consequences.[4] Science and technology are connected, but society's role in their application is typically overlooked. Both fields are usually taken for granted, as objective truth, instead of considering their political and social dimension and the consequent fallibility of that. Over the years, an entire philosophy of science and technology has developed to better understand the relations between science, technology and society. In parallel, new terms

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[1] Sheila Jasanoff, 'A Field of Its Own: The Emergence of Science and Technology Studies' in Robert Frodeman (ed), *The Oxford Handbook of Interdisciplinarity* (Oxford University Press 2017); S Jasanoff and others, *Handbook of Science and Technology Studies* (SAGE Publications 2001); J Thompson Klein, *Transdisciplinarity: Joint Problem Solving Among Science, Technology, and Society: An Effective Way for Managing Complexity* (Springer Science & Business Media 2001); Dana L Zeidler and others, 'Beyond STS: A Research-Based Framework for Socioscientific Issues Education' (2005) 89 Science education 357; Steve Woolgar and Javier Lezaun, 'The Wrong Bin Bag: A Turn to Ontology in Science and Technology Studies?' (2013) 43 (3) Social Studies of Science 321.

[2] G Giacomelli and R Giacomelli, 'Science, Technology and Society', in RA Carrigan, G Giacomelli and N Paver, *Non-Accelerator Astroparticle Physics* (WORLD SCIENTIFIC 2005).

[3] Harvey Brooks, 'The Relationship between Science and Technology' (1994) 23 Research Policy 479-484.

[4] Andrew Webster, *Science, Technology and Society: New Directions* (1st edn, Bloomsbury Publishing Plc 1992).

such as "Technoscience"; "Science, Technology, and Society (STS)" as well as "Science and Technology Studies" emerged to denote this intricate relationship. These terms encompass a wide range of disciplines, but their collective use all mean that science and technology are seen as human activities and products, conducted in a social environment rather than being merely simple applications of knowledge. This new discipline engaged in philosophical debates on science, technology, and society, with some focusing on internal aspects, such as language and structure with others focusing on external aspects like history, economy, and politics.[5] Based on this, several scholars, across various human eras, examined the relation between science, technology, and society. Amongst other major concerns, the objectivity and neutrality of these fields achieved prominence in debate among academics.[6] Indeed, this topic is as relevant now as it was in previous centuries, despite the difference in technological and scientific advancement from then.[7] The STS field has gained importance in the last century, in particular since the 1960s and 70s, a time characterized by escalating social unrest and activism tackling social issues such as the environment and civil rights. A growing recognition of the need to address the societal impact of science and technology has led to increased attention for these fields. This attention resulted in the creation of various committees and organizations, the adoption of new rules regulating the use of science and technology, and an increased academic focus on this issue.[8] Additionally, discussions concerning society's impact on science and technology are continuing to take place, connecting the past, the present, and the future all together.[9] Indeed, current studies examine the intersections between science technology and society their regulation as well as, the potential effect on society of technological and scientific advancements.[10] Issues being examined include: science and technology's relationship in the context of blockchain technology[11]; social media; automated vehicles; food and energy security and sustainability; political security, and stability in places such as the Middle East and Africa, among many other things.[12] In addition to the Global North,

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[5] Wenceslao J González, 'The Philosophical Approach to Science, Technology and Society', in W J Gonzalez (ed.), *Science, technology and society: A philosophical perspective* (Netbiblo 2005).

[6] Kristin Shrader-Frechette, 'Objectivity and Professional Duties Regarding Science and Technology', in W J Gonzalez (ed.), *Science, technology and society: A philosophical perspective* (Netbiblo 2005).

[7] Robert K Merton, 'Science, Technology and Society in Seventeenth Century England' (1938) 4 Osiris 360.

[8] See: Stephen H Cutcliffe, 'Science, Technology, and Society Studies as an Interdisciplinary Academic Field' (1989) 11 Technology in Society 419; Klaus-Heinrich Standke and M Anandakrishnan, *Science, Technology and Society: Needs, Challenges and Limitations* (Elsevier 2013).

[9] Gert Verschraegen and others, *Imagined Futures in Science, Technology and Society* (Routledge 2017).

[10] Todd L Pittinsky (ed), *Science, Technology, and Society: New Perspectives and Directions* (Cambridge University Press 2020).

[11] Paolo Davide Farah and Marek Prityi, 'Public Administration in the Age of Globalization and Emerging Technologies from Theories to Practice Symposium Issue: Blockchain Technology and the Law' (2019) 88 UMKC Law Review 397; Poshan Yu, Ruixin Gong and Michael Sampat, 'Blockchain Technology in China's Digital Economy: Balancing Regulation and Innovation', *Regulatory Aspects of Artificial Intelligence on Blockchain* (IGI Global 2022).

[12] Heather Christina Lum, *Critical Issues Impacting Science, Technology, Society* (1st edition, IGI Global 2019); United Nations Commission on Science and Technology for Development, *The Role of Science, Technology and Innovation in Ensuring Food Security by 2030: Report: 2017* (UN 2017); Clark Miller, Daniel Sarewitz and Andrew Light, 'Science, Technology, and Sustainability: Building a Research Agenda' (2008) 319 Science 424; Yannis

the Global South is also voicing its concerns on how to best regulate and determine the position of law in producing and regulating innovations in science and technology.[13] Generative Artificial Intelligence models such as ChatGPT are one of the most recent testing grounds where we can find tension between law and technology.[14] International organizations such as the United Nations are also examining the way society produces, affects, and changes science and technology.[15]

Science and technological fields are rapidly evolving[16] and interacting with the law and its regulations.[17] In this context, various communities have played a role in the development of the intricate link, interplay and "nexus" between science, technology, and law. Indeed, with every scientific and technological discovery, more rules were developed to regulate the discovery and address any potential risk emanating from the use of it.[18] More recently and as an example, science and technology have been used in the further development of fields within international law, given the negative human-caused impact on the planet witnessed over the last few decades.[19] In fact, science and technology are seen as one of the reasons for the increased fragmentation of global law along sectoral lines instead of territorial ones.[20] Transnational law transcends state's boundaries and is being increasingly formed within sectors such as the environmental or financial one and not within the territory of the Modern State. At the same time, the rapid scientific and technological developments in this field and others have affected the ability of lawyers and policymakers

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Stivachtis, 'Science, Technology and Security in the Middle East' (*E-International Relations*, 23 May 2019) <https://www.e-ir.info/2019/05/23/science-technology-and-security-in-the-middle-east/> accessed 18 September 2023; African Union Commission, *Science, Technology and Innovation: Strategy for Africa 2024* (STISA 2024).

[13] In the past two decades China has been proactive in regulating new technologies and also in developing innovative approaches on the relations between state and society. See generally, Paolo Davide Farah, 'Trade and Progress: The Case of China' (2016) 30 Columbia Journal of Asian Law 51; Gregory Chin and Ramesh Thakur, 'Will China Change the Rules of Global Order?' (2010) 33 The Washington Quarterly 119; on the relations between state and society, see: Paolo Davide Farah and Davide Giacomo Zoppolato, 'Public Ownership and the WTO in a Post-Covid-19 Era: From Trade Disputes to a "Social" Function' (2022) 125 West Virginia Law Review; on Energy: Davide Giacomo Zoppolato and Shisong Jiang, 'China-MENA Energy Cooperation under the Belt and Road Initiative: Megaprojects, Economic Planning, and a Pragmatic Approach to the "Green" Transition' (2023) 16 The Journal of World Energy Law & Business 143; Jesse Rodenbiker, 'Making Ecology Developmental: China's Environmental Sciences and Green Modernization in Global Context' (2021) Annals of the American Association of Geographers 1.

[14] For an overview of Generative AI, see: Anis Koubaa and others, 'Exploring ChatGPT Capabilities and Limitations: A Critical Review of the NLP Game Changer'; on the issues of regulations, *see*: Philipp Hacker, Andreas Engel and Marco Mauer, 'Regulating ChatGPT and Other Large Generative AI Models', *Proceedings of the 2023 ACM Conference on Fairness, Accountability, and Transparency* (2023); Glorin Sebastian, 'Do ChatGPT and Other AI Chatbots Pose a Cybersecurity Risk?: An Exploratory Study' (2023) 15 International Journal of Security and Privacy in Pervasive Computing (IJSPPC) 1.

[15] IAEA, ITU, UNESCO, UNOOSA, WIPO, *Science, Technology and Innovation and Intellectual Property Rights: The Vision for Development* (Thematic Think Piece; May 2012).

[16] Christopher Freeman and Luc Soete, 'Developing Science, Technology and Innovation Indicators: What We Can Learn from the Past' (2009) 38 Research policy 583, 588.

[17] Simon A Cole and Alyse Bertenthal, 'Science, Technology, Society, and Law' (2017) 13 Annual review of law and social science 351, 351.

[18] Manfred Lachs, 'Thoughts on Science, Technology and World Law' (1992) 86 American Journal of International Law 673, 677.

[19] Lachs (n 29) 692.

[20] Andreas Fischer-Lescano and Gunther Teubner, 'Regime-Collisions: The Vain Search for Legal Unity in the Fragmentation of Global Law' (2003) 25 Mich. J. Int'l L. 999, 1000.

to catch up with this progress.[21] This has already, and is expected to, impacted the judicial-legal system both locally and globally.[22] Jurists and scientists have both assumed the responsibility of determining the domains of science and technology. Jurists are supposed to determine justice (not the truth) with their decisions. While scientists, with their expertise in science and technology, might be perceived as, or presumed to be aiming at, the objective truth. In recent years, as has happened in many different periods of history, tension between justice and truth is becoming common and more intense. Both jurists and scientists are criticized as being merely representatives of the elite: the so-called 'experts'. Hence, another dilemma is taking place as, on the one hand, we have experts and specialists and, on the other, we have the general populace, increasingly doubtful about the role of science and technology but also of truth and justice in contemporary society. Further, law has a regulatory role, overseeing the use of science and technology. Scientific and technological developments often outpace the law, making regulations unable to catch up with the fast-paced change of science and technology. As such, this interaction is quite a complicated one.[23] This is well documented in the literature as it is often extremely difficult to adapt legal frameworks to changing circumstances.[24] The push to be legally precise and comprehensive easily results in a practical disconnect with these fields.[25] This leads to questions of a moral and philosophical nature concerning the role of laws within these fields and whether they can truly lead to better transparency and accountability in this context.[26] Due to this, the last few decades have witnessed an increase in scholarly articles addressing the interplay between science, law, and technology regarding topics such as international economic law; the oceans; national security; anthropology; ethics, and capitalism.[27] Yet, there remains a growing need for research on law, science, and technology from a broader perspective,[28] given the necessity to bridge the existing gap

[21] Sheila Jasanoff (ed.), *Science at the Bar: Law, Science, and Technology in America*, vol 9 (Harvard University Press 1997) IX.
[22] Phil McNally and Sohail Inayatullah, 'The Rights of Robots: Technology, Culture and Law in the 21st Century' (1988) 20 Futures 119, 119.
[23] Shirley Johnson, 'Science and Technology v. Law, or a Plague on Both Your Houses: Comment' (1970) 47 Denver Law Review 565, 566.
[24] Lyria Bennett Moses, 'Agents of Change: How the Law 'copes' with Technological Change' (2011) 20 Griffith Law Review 763, 763.
[25] Roger Brownsword and Han Somsen, 'Law, Innovation and Technology: Before We Fast Forward—a Forum for Debate' (2009) 1 Law, Innovation and Technology 1, 3.
[26] Sheila Jasanoff, 'Serviceable Truths: Science for Action in Law and Policy' (2014) 93 Tex. L. Rev. 1723, 1723–1749.
[27] For some seminal books, See: Marie-Claire Foblets and others, *The Oxford Handbook of Law and Anthropology* (Oxford University Press 2022); Bryan Mercurio and Kuei-Jung Ni, *Science and Technology in International Economic Law: Balancing Competing Interests* (Routledge 2013); Davor Vidas, *Law, Technology and Science for Oceans in Globalisation: IUU Fishing, Oil Pollution, Bioprospecting, Outer Continental Shelf* (Brill 2010); Thomas A Johnson, *National Security Issues in Science, Law, and Technology* (CRC Press 2007); Christian Lenk and Nils Hoppe, *Ethics and Law of Intellectual Property: Current Problems in Politics, Science and Technology* (Routledge 2016); David F Noble, *America by Design: Science, Technology, and the Rise of Corporate Capitalism* (Oxford University Press, USA 1979).
[28] Arthur J Cockfield, 'Towards a Law and Technology Theory' (2004) 30 Manitoba Law Journal 383, 383–416.

between the law as written and where technology actually is.[29] This is despite the fact that such an inquiry was initiated years ago, when various studies attempted to understand who the actual decision maker is when science and technology are used for decision-making purposes,[30] be it scientists, regulators, or the public.[31]

In terms of the interplay between science and law, its study is not a recent phenomenon; in the past, this topic had gained prominence in literature where authors examined, for instance, the science of law;[32] whether the law is actually a science in itself;[33] how does the law behave towards science,[34] and what is the impact of science on legal objectivity?[35] It is in this context that new terms emerged, such as "Legal Science"[36] and "Scientific Law"[37] that have been examined by different scholars,[38] such as Kelsen.[39] Both fields are characterized by formal rationality and both have their limitations. Decisions made by jurists or scientists are usually the product of careful deliberation and/or consensus among a specific epistemic community where culture, history, and institutions, among other factors, affect their development. Science and law are separate, but dealing with similar issues, even if one determines truth where the other determines justice. In an ideal world, one would expect that both fields could coexist in harmony, a world where science is used for drafting sound legislation as well as tackling court cases and legal procedures. Justice and truth would proceed hand in hand, mutually supporting each other, while working for the greater benefit of humankind. The political dimension involved within the two domains is, however, shaping both law and science. Thus, tension and conflict arise due to diverging epistemological assumptions and priorities. As an example, lawyers and judges make their determinations and judgments, even when uncertainty exists, whereas, from a scientific point of view, 'fact' has a much higher standard of admissibility in a legal context. New discoveries or new scientific facts, even if determined as the truth by the scientific community, are in several cases excluded by the proceedings or for lack of knowledge on the part of the legal experts or for simple incompatibility of the scientific new truth with

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[29] Paul Hunton, 'The Stages of Cybercrime Investigations: Bridging the Gap between Technology Examination and Law Enforcement Investigation' (2011) 27 Computer Law & Security Review 61, 51.

[30] TA Cowan, 'Decision Theory in Law, Science, and Technology' (1963) 140 Science (New York, N.Y.) 1065, 1065–1075.

[31] Mads Borup and others, 'The Sociology of Expectations in Science and Technology' (2006) 18 Technology analysis & strategic management 285, 287.

[32] Robert D Taylor, 'Ancient Tradition—The Relationship of Science and Law', *Forensic Science and Law* (CRC Press 2005).

[33] MC Roos, 'Is Law Science?' (2014) 17 Potchefstroom Electronic Law Journal/Potchefstroomse Elektroniese Regsblad 1391.

[34] Kirk W Junker, 'Comparing Law as Science with Science in the Law: Preliminary Thoughts' (2017) 14 Law Forensic Sci 82, 83.

[35] Alain Pottage and Martha Mundy, *Law, Anthropology, and the Constitution of the Social: Making Persons and Things* (Cambridge University Press 2004) 73–114.

[36] Junker (n 61) 91.

[37] Igor Hanzel, *The Concept of Scientific Law in the Philosophy of Science and Epistemology: A Study of Theoretical Reason* (Springer Science & Business Media 1999).

[38] KN Llewellyn, 'The Theory of Legal Science, The' (1941) 20 North Carolina Law Review 1.

[39] Peter Langford, Ian Bryan and John McGarry (eds), *Kelsenian Legal Science and the Nature of Law*, vol 118 (Springer International Publishing 2017) 1–10 <http://link.springer.com/10.1007/978-3-319-51817-6> accessed 18 September 2023.

justice. Uncertainty and complexity, while essential within the scientific domain, are excluded from law which necessitates certainty. The legal system's quest for certainty adopts rules and issues court rulings with justice as determined in specific and contingent cases, sometimes relying on standards of proof loosely mirroring the one used in science[40] and in accordance with its "truth".[41] This is further worsened by the fact that what constitutes science was heavily contested in previous centuries by various actors, such as religious authorities, impacting the adoption of laws, and the resulting confusion concerning the nature of science remains up to the present.[42] This fact has led to calls toward bridging the gap between scientists and lawyers, especially since each community focuses on its own priorities and goals without engaging or considering the impact of their work on the other field.[43] Understanding the position of science within law, and vice versa, requires careful consideration in light of the different epistemological premises of the two domains,[44] law delivering justice where science delivers truth. In fact, bridging this gap is especially difficult, given the existing differences between legal reasoning and scientific reasoning. For instance, scientists have access to much and more empirical data whereas lawyers must present their case to a judge immediately, only taking into account the existing evidence.[45] Thise interplay between law and science is even more complicated currently, given that it is occurring in a blockchain, knowledge-based society where legal regulation and scientific advice should be viewed as complementary to each other.[46]

In terms of the interplay between technology and law, each field often interacts with the other. In fact, this increasing interconnection has resulted in the emergence of new terms such as "Techno-Regulation" and "Normative Technology",[47] given the need to regulate the use of technology in society and consider various factors that do not have a technical nature.[48] Technology may support the rule of law by enhancing the ability to reach a legal objective, facilitating access to justice, increasing transparency, or eliminating discrimination. It may also act as a means of enforcing compliance by prohibiting the breach of law such as in the case of minors seeking to access certain websites.[49] Simultaneously, technology has the capacity to negatively affect legal interests and values

[40] Lee Loevinger, 'Standards of Proof in Science and Law' [1992] Jurimetrics 323, 323–325.
[41] Margaret A Berger and Lawrence M Solan, 'The Uneasy Relationship Between Science and the Law: An Essay and Introduction" (2008)' 73 Brooklyn Law Review 3, 847–856; Jasanoff (n 45) 1724–1730.
[42] Robin Feldman, 'Historic Perspectives on Law & Science' [2009] Stan. Tech. L. Rev. 1, 1–4.
[43] Micah L Berman and Annice E Kim, 'Bridging the Gap between Science and Law: The Example of Tobacco Regulatory Science' (2015) 43 Journal of Law, Medicine & Ethics 95, 95–98.
[44] Robin Feldman, *The Role of Science in Law* (Oxford University Press 2009).
[45] Phoebe C Ellsworth, 'Legal Reasoning and Scientific Reasoning' (2011) 63 Ala. L. Rev. 895, 907–915.
[46] Nico Stehr and Bernd Weiler (eds), *Who Owns Knowledge?: Knowledge and the Law* (Transaction Publishers 2011) 67–87.
[47] Erica Palmerini and Elettra Stradella, *Law and Technology: The Challenge of Regulating Technological Development* (Pisa University Press 2013) 14.
[48] Mario Biagioli and Marius Buning, 'Technologies of the Law/Law as a Technology' (2019) 57 History of Science 3, 544–550.
[49] Palmerini and Stradella (n 89) 14; James E Cabral and others, 'Using Technology to Enhance Access to Justice' (2012) 26 Harv. JL & Tech. 241.

protected by regulation.[50] Therefore, a legal assessment of technology is a must,[51] especially its impact on the individual,[52] resulting in the necessity for using legal ethics in its regulation.[53] Moreover, it is becoming increasingly difficult for the law to catch up with all technological developments taking place, that could in turn contribute to exacerbate technology's impact on society and the economy as well as its potential for changing the relation between citizens and the government.[54] Given this dilemma, there is a growing need for research on law and technology, providing a critical evaluation of this interplay in the broader sense,[55] especially considering the interdisciplinary nature of technological developments.[56] Issues to be examined include: the historical interplay of law and technology; the role of culture, and the role of international law among many other things.[57] Indeed, lawyers and scholars have already started examining the legal consequences of the use of new technologies, resulting in new specialties and expertise as well as new scholarly journals addressing the interplay between law and technology.[58] Because of this, law and technology as a term has been used extensively in the literature that described this interdependency as both simple and complex at the same time, calling for improvements as well as addressing existing challenges.[59] Suggestions have been made to use a general theory of laws in the regulation of technologies for the purpose of adapting the law to constant technological developments.[60]

The book *Science, Technology, Policy and International Law* presents innovative insights into the role of science in the decision-making process. In times when scientific knowledge and, in general, expertise is constantly in question it is necessary to reassess the relationship between science and transnational regulations. COVID-19, and the initial slow and contradictory responses to the issue, highlights how policymaking, even when scientific

[50] Cockfield (n 49) 384–388.
[51] Philip L Bereano, 'Saving Us From Ourselves: The Interaction of Law and Science-Technology: Comment' (2021) 47 Denver Law Review 671, 677.
[52] Nicola Lucchi, *The Impact of Science and Technology on the Rights of the Individual*, vol 26 (Springer International Publishing 2016) <http://link.springer.com/10.1007/978-3-319-30439-7> accessed 18 September 2023.
[53] Richard Zorza, 'Re-Conceptualizing the Relationship between Legal Ethics and Technological Innovation in Legal Practice: From Threat to Opportunity' (1998) 67 Fordham L. Rev. 2659.
[54] Noel Cox, 'The Relationship Between Law, Government, Business and Technology' (2006) 8 Duq. Bus. LJ 31, 31.
[55] Cockfield (n 49) 384–388.
[56] Giorgia Guerra, 'An Interdisciplinary Approach for Comparative Lawyers: Insights from the Fast-Moving Field of Law and Technology' (2018) 19 German Law Journal 579, 579–580.
[57] Kieran Tranter, 'The Laws of Technology and the Technology of Law' (2011) 20 Griffith law review 753, 753–760; Joseph W Dellapenna, 'Law in a Shrinking World: The Interaction of Science and Technology with International Law' (1999) 88 Ky. LJ 809, 809.
[58] Lyria Bennett Moses, 'How to Think about Law, Regulation and Technology: Problems with 'Technology'as a Regulatory Target' (2013) 5 Law, Innovation and Technology 1, 1–7.
[59] Daniel J Gifford, 'Law and Technology: Interactions and Relationships' (2007) 8 Minn. JL Sci. & Tech. 571, 571–587.
[60] Gregory N Mandel, 'History Lessons for a General Theory of Law and Technology' (2007) 8 Minn. JL Sci. & Tech. 551, 551–570.

data are presented, tends to underestimate health risks and is built on uncertainty.[61] Mediation amongst different interests is a key part of decision making but, when data or science is not used in order to reach equilibrium, negative outcomes could arise. By relying on anti-science rhetoric and cultural absolutism, populist movements sprouted in Europe and across the globe in the last decade. This backlash is not limited to the political establishment or elite but is also directed against actors shaping and producing scientific knowledge.[62] This loss of confidence and trust in politicians and the scientific community is also a clear reflection of the inability of the establishment to deal with societal, civic, and sustainability crises in a timely manner.[63] A globalization too focused on economic growth, at the expense of non-trade concerns,[64] has had a role in strengthening the foundation and radicalism of populist political spaces. Economic inequalities, as well as cultural factors, affect the relationship of trust between rulers and the citizenry in almost every aspect of policymaking.[65] At the national and local level, science-based decision-making is in crisis; at the international level and, especially in multilateral institutions, it is still the preferred tool to design effective policies. International experts communicate via a general and mutually agreed-upon language in order to build effective transnational regulation. However, the lack of accountability and transparency in the work of experts is, in this context, damaging the further development of science-based decision-making. A more transparent regulatory framework regarding the role of experts could revive the importance of science in designing effective and socially responsive international policies and regulation.[66] This edited collection offers answers on how to best integrate knowledge and science in policy making, and it reviews other current attempts made at the transnational and international level. By building on a functionalist and comparatist approach to international law, this book clarifies what the role of science is in the current transnational governance framework. Case studies within span across different disciplines

[61] For an overview of initial reactions on the pandemic and the role of uncertainty see, Christopher M Weible and others, 'COVID-19 and the Policy Sciences: Initial Reactions and Perspectives' (2020) 53 Policy sciences 225; Paola Rebughini, 'A Sociology of Anxiety: Western Modern Legacy and the Covid-19 Outbreak' (2021) 36 International Sociology 554; On the relations between science and media, see: The Lancet Infectious Diseases, 'The COVID-19 Infodemic' (2020) 20 The Lancet. Infectious Diseases 875; Amy Koerber, 'Is It Fake News or Is It Open Science? Science Communication in the COVID-19 Pandemic' (2021) 35 Journal of Business and Technical Communication 22; Salman Bin Naeem and Rubina Bhatti, 'The Covid-19 "Infodemic": A New Front for Information Professionals' (2020) 37 Health Information & Libraries Journal 233.

[62] Niels G Mede and Mike S Schäfer, 'Science-Related Populism: Conceptualizing Populist Demands toward Science' (2020) 29 Public Understanding of Science 473.

[63] Margaret Stout and Jeannine M Love, *A Radically Democratic Response to Global Governance: Dystopian Utopias* (Routledge, Taylor & Francis Group 2016).

[64] Countries that strengthen the provision of socio economics and cultural rights and promoted the protection of non-trade concerns at a national level witnessed lower level of grass-roots populism. For an overview of the progress of China, see: Paolo Davide Farah, 'Trade and Progress: The Case of China' (2016) 30 Columbia Journal of Asian Law 51; Paolo Farah and Elena Cima (eds), *China's Influence on Non-Trade Concerns in International Economic Law* (Routledge 2016).

[65] Dani Rodrik, 'Populism and the Economics of Globalization' [2018] Journal of International Business Policy 1; Abdul Noury and Gerard Roland, 'Identity Politics and Populism in Europe' (2020) 23 Annual Review of Political Science 421.

[66] Alessandra Arcuri and Florin Coman-Kund, *Technocracy and the Law: Accountability, Governance and Expertise* (Routledge 2021).

and regimes ranging from emerging environmental protection technologies to statistics. This book is complemented by a new, solid theoretical framework which seeks to reassess the relationship between law and science.

Kirk Junker in *Facts Are the Moveable Furniture of the Legal Mind, Not Stones of Science*[67], breaks down the differences between truth and opinion, the first built upon the burden of proof and the second on the burden of persuasion. We are moving towards an era in which the personal beliefs of both individuals and institutions are made superior to facts. Beliefs thus gain the same importance as established knowledge, where individuals can freely determine their truth based on persuasion. Not limited to this post-truth era, science has been in crisis since the industrial revolution with the advent of globalized capitalism.[68] What is different now is that humans today increasingly act against rationality and following fake news and misinformation. As a result, rationality is not the default pattern of behavior and, many individuals form biased opinion not based on facts but on emotions and intuitions. Kirk Junker sheds light on how the very basic notion of fact, transitioned from law to the natural field. Such transition has had a role in positioning the scientific paradigm as the preferred lens through which understand reality. The production of scientific knowledge is built on replicability and on the certainty that a specific phenomenon will take place if the same conditions are met. On the contrary, replicability, as well as being a predefined and immovable approach, is antithetical to law. In fact, law requires finding solutions to different or equal problems based on social and cultural context and a margin of flexibility in the interpretation of social reality that is excluded from science. A law too tied to the scientific understanding of fact is, in the post-truth era, unable to respond to global challenges. Kirk Junker looks at the so-called "iGeneration's" role in shaping reality, as well as to the role of technology in forming knowledge and challenging the roles of science and law. The author also highlights the relationship between humans and reality and how it is grounded on irrationality and tries to explain the features of this 'irrationality 2.0': the arrogant intentional pursuit of power, the citizen who unintentionally contributes to the proliferation of untruths, and the citizen who has been conditioned to think that truth is not an important category of human thought. How should we counterbalance irrationality? For Kirk Junker, the solution lies in the use of law as a tool to mitigate the features of irrationality, and he finds in the courtroom a locus where rationality is used to construct social facts. Under this equation, law should act as the basis of the judgment while science could be helpful in foregrounding the judgment on rationality.

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[67] Kirk Junker, 'Facts Are the Moveable Furniture of the Legal Mind, Not Stones of Science' in Justo C Varela and Paolo D Farah (eds), *Science, Technology, Policy and International Law* (Routledge 2024).

[68] Jean-Francois Lyotard, *The Postmodern Condition: A Report on Knowledge* (Manchester University Press 1984) 39'The "crisis" of scientific knowledge, signs of which have been accumulating since the end of the nineteenth century, is not born of a chance proliferation of sciences, itself an effect of progress in technology and the expansion of capitalism. It represents, rather, an internal erosion of the legitimacy principle of knowledge. There is erosion at work inside the speculative game, and by loosening the weave of the encyclopedic net in which each science was to find its place, it eventually sets them free.' .

Departing from the same idea of the previous chapter, that is, the evolution from a rationality-based truth to a narrative model of truth (Junker's distinction between truth and opinion), in *The Interlinkages Science-Technology-Law: Information and Communication Society, Knowledge-Based Economy and the Rule of Law* [69], Giovanni Bombelli and Paolo Davide Farah construct a model to understand the complex relationship between science, technology, society, and law. As the first relation under analysis, the authors connect the issue of the democratic deficit with the technology-society nexus. The democratic deficit is a consequence of the lack of adaptability of western democracy to complex (information) societies. In this context, technology expands the amount of available information and facilitates their accessibility. Yet, it decreases the reliability and accuracy of information, giving rise to tensions that challenge the role of information in advancing societal knowledge. By breaking the link between information and knowledge, technology also shifts societies towards technocracy. In this sense, legitimacy in democracy is not defined anymore by truth but by the ability of politicians to produce large amount of information and engage with different sectors of the society.

As a second set of relations, the authors assess technology and law. Law is increasingly being reduced to a normative technique, driven by its lateness and incompleteness to adapt and anticipate technological changes. Thus, for the authors we are witnessing a transition from hard law to soft law, from norms to rules, from government to governance. At the same time, technology aims to be recognized as a legal framework based on the new "net/web" relationship, applied to new spaces (cyberspace) and based on accountability instead of sovereignty. This new legal structure would operate in the "net" society (interactive, dematerialized and based on database memory) where cognitive acquisition (hypertextualization of knowledge, cyberculture) simplifies political deliberation to simple expressions of subjectivism and emotive decisions based on casual and contingent information. As a result, in highly technologized and mass societies there is a dislocation between information and knowledge, which can no longer identify each other. Technological and scientific developments are currently affecting legal systems at the national and international levels, and legislators are facing great challenges when it comes to their regulation.

In *Using Flexibility Mechanisms for Addressing Technological and Scientific Developments: Examples from Selected Global Regulatory Frameworks*[70]**,** Imad Antoine Ibrahim shows that this is mostly due to existing uncertainties, lack of knowledge, and the rapid progress occurring in these fields. The situation is further complicated, as these

[69] Giovanni Bombelli and Paolo D Farah, 'The Interlinkages Science-Technology-Law: Information and Communication Society, Knowledge-Based Economy and the Rule of Law' in Justo C Varela and Paolo D Farah (eds), *Science, Technology, Policy and International Law* (Routledge 2024).

[70] Imad Antoine Ibrahim, 'Using Flexibility Mechanisms for Addressing Technological and Scientific Developments: Examples from Selected Global Regulatory Frameworks' in Justo C Varela and Paolo D Farah (eds), *Science, Technology, Policy and International Law* (Routledge 2024).

developments affect all aspects of human society, including the law (and vice versa[71]), and are developed in the global arena where international law is needed to govern the use of technologies and sciences. It is precisely on the details regarding international law, given the critical role that it is expected to play, that this chapter is focused on. Scholars in recent years have been attempting to provide suggestions and solutions concerning the way emerging technologies and sciences can be regulated. In this context, Ibrahim examines the inability of current law to keep up with technological and scientific development and other issues that arise when trying to regulate them, for example, the fact that new technologies often do not fit in the general framework of existing rules and legal categories. To help solve these problems, the author argues for the use of existing flexibility mechanisms from different global regulatory frameworks when adopting new agreements and instruments addressing technologies and sciences in the international sphere. Ibrahim provides examples of these mechanisms as developed within international financial law. He uses several examples to demonstrate his point. As an example, he analyzes the concept of sandbox that allows testing in a safe environment under the supervision of the proper authorities. Another is the use of Art XX of GATT in international trade law, which allows the restriction or control of technological developments in justified cases. In the case of international climate change law, Ibrahim describes how the success of the Paris Agreement was also due to its mechanism to ease implementation and compliance via non-binding commitments[72] or as in international water law where flexibility mechanisms exist in the context of amendment and review procedures or for joint management institutions.[73]

Alessandra Donati in *The Precautionary Principle Under EU Law: A "Post-Modern" Principle in a "Post-Truth" Era*[74] shifts the focus on how law is being formed in the post-truth era. Donati seeks to explain the precautionary principle from a philosophical standpoint. The author frames this principle as an example of a post-modern legal framework. Alessandra Donati begins with an assessment of the core characteristics of modern law (systematic, general, universal, and stable) and postmodern law (disorder, complexity, indeterminacy, and relativism). This change could also be seen in the increasing decline of multilateralism as the expression of modern law. Both efficiency and fragmentation, instead of coherence and consistency, are for the author a radical change in perspective in postmodern law. Consensus decision-making is not able to keep up with the fast-paced changes of post-truth reality; therefore, other deliberation methods are preferred. This could also be seen in the lack of precision, clarity, and vagueness of postmodern law as in the case of the precautionary principle or the predominance of non-binding, often empty, contents of political principles. Based on the author's reconstruction, these political principles continue to guide the decision-making process. Political dimensions have always

[71] Diganth Raj Sehgal, 'Relationship Between Law, Science, and Technology in Modern Society' (PLEADERS, 3 March 2021) <https://blog.ipleaders.in/relationship-law-science-technology-modern-society/>.
[72] United Nations, Paris Agreement (2015), Art. 15(1).
[73] Heather Cooley and Peter H Gleick, 'Climate-Proofing Transboundary Water Agreements' (2011) 56 Hydrological Sciences Journal 711.
[74] Alessandra Donati, 'The Precautionary Principle Under EU Law: A "Post-Modern" Principle in a "Post-Truth" Era' in Justo C Varela and Paolo D Farah (eds), *Science, Technology, Policy and International Law* (Routledge 2024).

played a role in shaping and producing science and technology, not just in the post-truth era. Alessandra Donati highlights how the precautionary principle links different regimes and disciplines and, most importantly, broadens the focus of law by including social and ethical considerations resulting from dialogue and exchanges.

After reviewing the precautionary principle from a theoretical perspective, Justo Corti Varela in *The Precautionary Principle and the Burden of Proof in International Risk Regulation Trials*[75] analyses how the principle is interpreted and applied by international courts. More specifically, Justo Corti investigates how a "modern" law institute – i.e., the burden of proof – is affected by postmodern law. In designing a socially responsive burden of proof, international courts help in clarifying the relationship between these apparently contradictory realms. Despite not having yet been recognized as a customary principle of international law[76], the use of the precautionary principle in international law is possible in cases of scientific uncertainty.[77] Corti studies it as a decision-making tool for making procedural decisions in judicial trials, such as the burden or assessment of proof.[78] The adjudicatory vision of the precautionary principle could contradict the classical *actori incumbit probatio*. To resolve this contradiction, the following solutions have been explored within international case law - where the lack of explicit wording in the procedural rules permits international courts to modulate the precautionary principle according to the circumstances: a call for collaboration in the production of evidence, a shift in the burden of proof, or a reduction of the standard of proof. All three of these solutions have been analyzed in both interim orders and substantive proceedings occurring

[75] Justo Corti Varela, 'The Precautionary Principle and the Burden of Proof in International Risk Regulation Trials' in Justo C Varela and Paolo D Farah (eds), *Science, Technology, Policy and International Law* (Routledge 2024).

[76] Discussion has been particularly intense in WTO case law where, due to the lack of official recognition in its treaties (as explained in footnote 3), it would be applicable only when it can be demonstrated that the precautionary principle was a general principle of customary international law, something that "appears less than clear." See Appellate Body Report, European Communities — Measures Concerning Meat and Meat Products (Hormones) WT/DS26/AB/R; WT/DS48/AB/R (January 16th, 1998) hereafter AB EC-Hormones, paras. 123 and 124; and, Panel report EC-Biotech Products, paras. 7.73 and 7.89. Beyond the WTO, only an award of the Permanent Court of Arbitration has recognized it clearly, in the Iron Rhine Railway case (Reports of International Arbitral Awards, vol. XXVII, pp. 35-125, para. 59). In EU law it has been recognized as "EU" general principle (see case C-180/96, ECLI:EU:C:1998:192, para. 99-101; and case C-157/96, ECLI:EU:C:1998:191 para. 62-64). International literature agrees that is a "emerging" principle: David Freestone, 'Caution or Precaution:"A Rose By Any Other Name..."?' (1999) 10 Yearbook of International Environmental Law 25;]; or that, at least, that it start to be an international custom: Philippe Sands and Jacqueline Peel, *Principles of International Environmental Law* (Cambridge University Press 2012] This idea of a principle in progress has been incorporated in the Seabed Dispute Chamber of ITLOS (see Advisory Opinion of 1 February 2011, para. 135.

[77] Elizabeth Fisher, *Risk Regulation and Administrative Constitutionalism* (Bloomsbury Publishing 2007).

[78] Caroline E Foster, *Science and the Precautionary Principle in International Courts and Tribunals: Expert Evidence, Burden of Proof and Finality*, vol 79 (Cambridge University Press 2011) For the distinction between "administrative" and "adjudicative" burdens of proof in the application of the precautionary principle, see Panel Report Japan – Measures Affecting Agricultural Products, WT/DS76/R, (October 27th, 1998) hereafter PR Japan - Agricultural Products, para. 8.13 and Panel Report Japan – Measures Affecting the Importation of Apples, WT/DS245/R, (July 15th, 2003), para. 8.41. For other "archetypical versions" of the precautionary principle ("uncertainty does not justify inaction," "uncertainty justifies action," and "shifting the burden of proof") see Lavanya Rajamani and Jacqueline Peel, *The Oxford Handbook of International Environmental Law* (Oxford University Press 2021) ch 18.

before international courts. Corti concludes in his study that the precautionary principle's acceptance does not yet go beyond administrative risk management.
Sound science-based decision-making should also integrate ethics in order to be effective. Moral dilemmas can arise, especially in fields related to individual rights such as health and reproduction and sexuality. To what extent should the law intervene in this context? Antonio Quiros Fons in *The Precautionary Principle and the Burden of Proof in International Risk Regulation Trials*[79] investigates ethical concerns and the role of law. Antonio Quiros Fons reviews how conscientious objection paved the way for a discussion in the international community of how far positive laws could regulate human behavior. After reviewing how the conscientious objection was included under article 18 of the International Covenant on Civil and Political Rights (ICCPR) Antonio Quiros Fons analyses the institutionalization process of this right. The inclusion of this right, based on religious grounds, at an international court (European Court of Human Rights–- ECHR), and then at a constitutional level, emphasizes the importance of adapting to changing circumstances. Conscientious objection shares commonalities with reproductive services in the sense that both are connoted by a strong ethical dimension. The decision to perform or not to perform an abortion procedure, along with other hotly debated issues in healthcare, such as euthanasia, are too often left to the physicians. While opting out for physicians should be allowed in principle, procedures should be greatly improved and rationalized. Opt-outs in no way should hinder, slow down, or affect patients' decisions. To do so, the author suggests that, on one hand, the refusal process should be streamlined, and, on the other, suitable replacements must be readily and easily available for patients. For Antonio Quiros Fons, an ecological approach could strengthen individual rights and, in the meantime, promote biodiversity.

Gemma Hobcraft in *Assessing the Soundness of Science to Determine Reactive and Proactive Regulatory Change. Human Fertilisation and Embryology Authority, Mitochondrial Donation, Treatment Add-ons and Future Challenges for Regulation*[80] expands the analysis of the relationship between science and law by specifically addressing assisted reproduction. Innovations in the reproductive field are not so easily received by international and national legislation. Along with difficulties in regulating such aspects from a legal standpoint, cultural and ethical considerations lead the debate. International documents are scarce, fragmented, and politically motivated.[81] National laws and regulation, therefore, fill this gap. Gemma Hobcraft investigates the example of the United Kingdom and how the main regulator in charge of this task - the Human Fertilization and Embryology Authority (HFEA) - is backed by scientific data to craft its regulations.

[79] Antonio Quiros Fons, 'The Precautionary Principle and the Burden of Proof in International Risk Regulation Trials' in Justo C Varela and Paolo D Farah (eds), *Science, Technology, Policy and International Law* (Routledge 2024).
[80] Gemma Hobcraft, 'Assessing the Soundness of Science to Determine Reactive and Proactive Regulatory Change. Human Fertilisation and Embryology Authority, Mitochondrial Donation, Treatment Add-ons and Future Challenges for Regulation' in Justo C Varela and Paolo D Farah (eds), *Science, Technology, Policy and International Law* (Routledge 2024).
[81] Guido Pennings, 'International Evolution of Legislation and Guidelines in Medically Assisted Reproduction' (2009) 18 Reproductive BioMedicine Online S15.

Specific Sub-committees, such as the Scientific and Clinical Advances Advisory Committee (SCAA), have been established to keep up with advancements, not only in science but also in ethics. Science-based policymaking is even more relevant in contexts such as add-ons where the shift from research to treatment took some time. Gemma Hobcraft, in the final section of the chapter, critically assesses potential challenges related to human fertilization and embryology, such as privacy, genetic testing, and treatment for non-UK nationals. The diverging approach taken by the HFEA (proactive in the case of add-ons and reactive in the case of mitochondrial donation), highlights the difficulties faced by an independent agency to include science within a regulatory framework. Gemma Hobcraft suggests that regulations should be, in the meantime, proactive and reactive to further scientific research but simultaneously integrating ethical considerations. Her chapter also points out how science is assessed not only by experts but also by governments in formulating policy.

This collection then moves from science to the impact of emerging technologies on decision-making. Mihail Stojanoski and Lilla Vukovich in *Use of Smartphone Applications in the Democratic Decision-Making Process*[82] dissect how technology is set to change consumers' behavior. E-voting not only affects consumers' behavior but also influences the deliberation process. Smartphones are an essential and convenient daily tool for most of the population. Not only could they influence voting, but they are also already influencing how citizens receive political information. While e-voting has been on the agenda of the European Union since 2004, little progress has been made in this regard. The post COVID-19 pandemic could speed up the adoption of e-voting at a larger scale, to reduce the spread of the virus. Mihail Stojanoski and Lilla Vukovich analyze several examples, both in the United States (West Virginia) and Europe (Estonia and Switzerland), where e-voting has been experimented with. Recent advances in technology, such as distributed ledger technology and biometrics, made these examples possible. These issues continue to arise ranging from privacy concerns via cyber-attacks to the involvement of third parties in the national voting process. Mihail Stojanoski and Lilla Vukovich highlight the downfalls and benefits of e-voting.

The relation between science and law is clarified from a more practical perspective from Ciarán Burke and Alexandra Molitorisová in *Procedural versus Substantive Approaches to Scientific Evidence in the Opinions of Advocates-General.*[83] More specifically, the authors analyze how evidence is used and evaluated in the European Court of Justice (ECJ).

[82] Mihail Stojanoski and Lilla Vukovich, 'Use of Smartphone Applications in the Democratic Decision-Making Process' in Justo C Varela and Paolo D Farah (eds), *Science, Technology, Policy and International Law* (Routledge 2024).

[83] Ciarán Burke and Alexandra Molitorisová, 'Procedural versus Substantive Approaches to Scientific Evidence in the Opinions of Advocates-General' in Justo C Varela and Paolo D Farah (eds), *Science, Technology, Policy and International Law* (Routledge 2024).

Evidence is the point of contact and, often, conflict between law and other disciplines.[84] Ciarán Burke and Alexandra Molitorisová critically investigate this relation by building on the division between questions of fact and questions of law and how in, certain areas such as the proportionality analysis in the ECJ, the two apparently separated worlds blend together. The assistance of the Advocates General (AGs) regarding evidence is essential for the proper functioning of the Court. AGs are called when novel questions of law or cutting-edge scientific evidence are involved. Ciarán Burke and Alexandra Molitorisová propose an analytical framework based on core and shared characteristics of AGs opinions in light of EU law. So far, AGs have been principally involved in providing impact assessments of EU measures to the ECJ by using mostly statistics and econometrics. By offering an interpretation of notions or statutory terms, AGs help clarify and determine the factual circumstances of a case. Ciarán Burke and Alexandra Molitorisová also point out that AGs help adjudicators add weight and importance to particular evidence presented. Because of the increase of complexities and technicalities in law, and in light of the reduction of the clear division between questions of law and questions of fact, AG's involvement is urgently required to help the ECJ.

Climate change is a global phenomenon. Therefore, Paolo Davide Farah and Alessio Lo Giudice, in the chapter *Climate Justice in the Anthropocene and its Relationship with Science and Technology The Importance of an Ethics of Responsibility* introduce climate justice and globalization in the context of law, science and technology.[85] For the authors, globalization is the necessary hermeneutical horizon if one wants to develop an analysis of the metamorphosis that climate change could cause at a political, social, and economic level. Within this horizon, the authors show how the relationship between the concept of the Anthropocene[86] - from which climate change is its most obvious effect - and the request for justice allows for including political considerations such the effects of climate change within the legal system. Such a peculiar political interpretation coincides with the claim for climate justice, understood in the broadest sense as a conceptual strategy rooted in social movements, world civic politics, and political activism regarding climate change and environmental protection[87] and intergenerational equity. Indeed, in order to avoid the reduction of such a claim to the mere outcome of an ideological critique towards capitalism, the conception of climate justice needs to be sustained by a rational, ethical model. The

[84] William Twining, 'Evidence and Legal Theory' (1984) 47 The Modern Law Review 261, 264': If one looks at law as a discipline in these terms, it is hardly surprising that its relationship both with other disciplines and with the world of affairs is perennially problematic[…] The primary task of the jurist is to study the assumptions underlying the discipline of law: many of those assumptions lie at key points of contact between the world of learning and the worlds of practical affairs. […] Understanding law is dependent on understanding much else besides.'

[85] Paolo D Farah and Alessio Lo Giudice, 'Climate Justice in the Anthropocene and its Relationship with Science and Technology The Importance of an Ethics of Responsibility' in Justo C Varela and Paolo D Farah (eds), *Science, Technology, Policy and International Law* (Routledge 2024).

[86] Paul J Crutzen and Eugene F Stoermer, 'The "Anthropocene" (2000)' [2021] Paul J. Crutzen and the anthropocene: A new epoch in earth's history 19; Paul J Crutzen, 'Geology of Mankind' [2016] Paul J. Crutzen: A pioneer on atmospheric chemistry and climate change in the Anthropocene 211; Anu Valtonen, Outi Rantala and Paolo Davide Farah (eds), *Ethics and Politics of Space for the Anthropocene* (Edward Elgar Publishing 2020).

[87] Neil Carter, *The Politics of the Environment: Ideas, Activism, Policy* (Cambridge University Press 2018).

thesis of this chapter is that the concept of ethics of responsibility, inspired by Hans Jonas' well-known philosophy where future generations play a leading role,[88] could work as a promising rational foundation of the claim for climate justice. The ethics of responsibility, which acquire full meaning only in a global perspective, would also be aligned with principles established by the study and analysis of the dynamics between science, technology, and society.

Anthi Koskina in *The Science-Based Decision-Making Process as Established in the Paris Agreement (2015)* [89] explains how evidence-based decision-making entered the international community jargon thanks to environmental law. Since the 1992 Earth Summit, science has been used to build and legitimize the use of multilateralism for environmental protection purposes. Principle 15 of the Rio Declaration on Environment and Development posits: "lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation". Following declarations made under the premises of the United Nations Framework Convention on Climate Change (UNFCCC) acknowledged even more directly the link between science and law. As an example, it recognizes how the Kyoto Protocol centers around the role of non-state actors[90] and science in both reviewing and guiding the development of the environmental protection regime.[91] Anthi Koskina, following this line of reasoning, investigates how the Paris Agreement, concluded in 2016, attempted to build a newer framework grounded in science. The decision-making process of the Paris Agreement in fact highlighted how, at each of the stages, the common language of negotiators was science. Law was used by policymakers in order to balance the need to counteract the negative effects of climate change with economic, social, and cultural development. For Anthi Koskina, the multilateral environmental framework is a clear attempt at how to integrate science to the maximal extent in the context of policymaking. Sharing of scientific data, good practices, and experiences, as provided under the Paris Agreement, also affects national and local levels. Anthi Koskina concludes by looking at how the decision-making process of the Paris Agreement could positively influence member states and push them to design environmental policies based on science.

In sum, these contributions highlight the importance of addressing the topic of science and technology in the context of recent events and subject matters. These include Covid-19;

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[88] On the scholarship of Hans Jonas on environmental ethics: Theresa Morris, *Hans Jonas's Ethic of Responsibility: From Ontology to Ecology* (State University of New York Press 2013); Lewis Coyne, *Hans Jonas: Life, Technology and the Horizons of Responsibility* (Bloomsbury Publishing 2020); Vittorio Hösle, *Filosofia della crisi ecologica* (Einaudi 1992); Maria Loredana Furiosi, *Uomo e natura nel pensiero di Hans Jonas* (Vita e Pensiero 2003); Paolo Becchi, *La vulnerabilità della vita. Contributi su Hans Jonas* (La Scuola di Pitagora 2008); Karl-Otto Apel, Paolo Becchi and Paul Ricoeur, *Hans Jonas: il filosofo e la responsabilità* (Albo Versorio 2004).

[89] Anthi Koskina, 'The Science-Based Decision-Making Process as Established in the Paris Agreement (2015)' in Justo C Varela and Paolo D Farah (eds), *Science, Technology, Policy and International Law* (Routledge 2024).

[90] Art. 5 Kyoto Protocol: Methodologies for estimating anthropogenic emissions by sources and removals by sinks of all greenhouse gases not controlled by the Montreal Protocol shall be those accepted by the *Intergovernmental Panel on Climate Change*

[91] Karin Bäckstrand and others, 'Non-State Actors in Global Climate Governance: From Copenhagen to Paris and Beyond' (2017) 26 Environmental Politics 561.

politics, especially populism; globalization; economics; culture, and the environment. It also shows the importance of the law, specifically for regulation of the interplay of science and technology. This can be seen, for instance, through the flexibility mechanisms mentioned previously; the various legal principles, such as the precautionary principle, that must apply; the importance of international courts and regulatory authorities in the governance of science and technology, and the adoption of a pro-human rights approach to these issues. Finally, these contributions also touch upon the role of ethics, morals, and practicalities surrounding technology and science.