



Conceptual Developments in Environmental Law: An Interdisciplinary Approach

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Author's contribution

The sole author designed, analysed, interpreted and prepared the manuscript.

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ABSTRACT

This paper's point of view is that environmental law translates this particular evolutionary point in time into principles and rules, and highlights that given the extent and significance of the grave issues we are confronting, concepts that come from other sciences need to be dealt with carefully to ensure these are interpreted and implemented effectively. The grave concern about conservation of the environment and the urgent need for effective measures to protect it is a sign of the times, and it is growing deeper in view of the rapidly worsening climate crisis. Environmental law studies demonstrate that there is a line of force based on fluid, fruitful dialogue between different fields of knowledge. Lawyers are aware of the achievements made in environmental law, as well as its manifest deficiencies and limitations, and, just like Theseus who momentarily loses the golden thread offered by the bold Ariadne, they must find a way out of that labyrinth.

Keywords: Environment; law; risk; uncertainty; effectiveness.

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1. INTRODUCTION: A CHARACTERISTIC TRAIT OF ENVIRONMENTAL LAW LAYS ON ITS DEPENDENCY ON SCIENTIFIC AND TECHNOLOGICAL DEVELOPMENTS

The grave concern about conservation of the environment and the urgent need for effective measures to protect it is a sign of the times, and it is growing deeper in view of the rapidly worsening climate crisis. The negative effect of the level of industrial and technological development in some countries has resulted in an overall marked deterioration of the state of the biosphere [1-3]. This problem has turned into an existential challenge for the international community that is faced with the huge task of resolving the issue in a matter of a few decades.

There are obviously a number of different stances when it comes to assessing the scale of the environmental crisis. For some, the situation is not particularly serious. After all, throughout its history, our planet has experienced environmental disasters that originate from natural causes. Furthermore, encouraged by recent events such as the landing on Mars by NASA's explorer rover *Perseverance*, improvements in renewable energy or the promotion of electric vehicles, not to mention the development of several vaccines in record time to slow down the threat to public health posed by the new coronavirus, we place our trust in a form of "scientific and technological optimism". Therefore, the human species - an essential agent in the current environmental crisis - would be capable of resolving the crisis thanks to continuing advances being made in these and other fields¹. This line of reasoning accuses

those who do not share this optimism of assuming "alarmist"² or "extremist" views, or even of succumbing to an "environmental trend" or deferring to "city dweller elitism"³.

On the other hand, there are those who also hold different views when highlighting the particular seriousness of the current environmental and climate crisis [4-6]. As a result, they demand more drastic changes to current economic and energy policies to bring about a change in direction and a transition towards a society with greater environmental and ecological harmony⁴.

A more informative summary is provided in The Guardian's article, "Using hydrogen fuel risks locking in reliance on fossil fuels, researchers warn", 6 May 2021 (available at <https://www.theguardian.com/environment/2021/may/06/hydrogen-fuel-risks-reliance-on-fossil-fuels>).

² *A critical approach to the theory on a future collapse of our thermo-industrial civilisation in B. Louart, (2019), Dossier: La critique de la collapsologie. Happy collapse? 2015-2019 (available at <https://archive.org/details/dossiercollapsologie>).*

³ *It is true to say that, in reality, many social conflicts include environmental components which, in their own interests, can be mistaken for defending a social status that favours the wealthy. With regard to México, for example, see P. Ávila García, E. Luna Sánchez, [7], "Del ecologismo de los ricos al ecologismo de los pobres", Revista Mexicana de Sociología 75, no. 1 (January - March), pp. 63-89 which studies the creation of protected natural areas on the Costa Alegre in the state of Jalisco as a means to facilitate the construction of luxury tourist resorts and ban the local population from their land and its traditional use. As the authors point out, "the environmental debate has been a clever means of enabling the elitists in national and international government to penetrate what little remains of the common assets and natural resources on the Jalisco coast. Environmental policy has been used to make the impossible possible by cover up or "legitimation" provided by environmental impact studies and environmental protection orders" (Ibid., p. 86).*

⁴ *The so-called "ecological transition" whose name, where the environment is concerned, suggests, in Picazo's words, that: "... it is about moving away from an unsustainable, toxic, inefficient production and consumption model based on fossil fuels, that ravages the countryside and nature, to an alternative, sustainable one based on the circular economy, efficiency, nature conservation, public environmental awareness, eco-industry, organic farming and renewable energy" (E. Picazo, "Transición ecológica", La Opinión, 23 April 2021 (available at <https://www.laopiniondemurcia.es/>).*

According to García's attempt to conceptualise the term, ecological transition "... would be a gradual process of changes to production and consumption systems, to social and political institutions and ways of life and the public's values, that goes from the current situation, which is too costly on the environment and therefore full of excessive risks, to a future, environmentally sustainable situation that is compatible with the planet's ability to maintain human activity. All of this would be achieved without making any substantial changes to how economic activity is organised or to the basic format of the democratic political system, while maintaining, or even increasing, the population's current level of fulfilment of its material needs" (E. García, "La transición ecológica: definición y trayectorias complejas", Ambienta, no. 125, 2018, p. 88). Ibid., pp. 90-92 for a critical consideration of the ecological transition designed to be a simple "ecological modernisation".

¹ *On the potential of hydrogen and the priority given by the EU's economic recovery programme to this new source of secondary energy in the framework of the European Green Deal, see Van Renssen, S. (2020), "The hydrogen solution?", Nature Climate Change, vol. 10, pp. 799-801.*

An example of a critical opinion about the growing use of biofuels and hydrogen during the energy transition period is expressed by F. Ueckerdt, C. Bauer, A. Dimachner, J. Everall, R. Sacchi, G. Luderer (2021), "Potential and risks of hydrogen-based e-fuels in climate change mitigation", Nature Climate Change (accessible at <https://doi.org/10.1038/s41558-021-01032-7>). Specifically, the authors highlight that no contribution to mitigating the effects of climate change can be expected before 2030 in the majority of countries and energy systems by using biofuels and hydrogen, unless they are imported from countries that have created additional renewable capacity, and that have electrolyzers and Direct Air Capture (DAC) plants, as well as the appropriate infrastructure to store and transport CO₂.

By taking this point of view, we would be witnessing a real change in the cultural and social paradigm, driven by growing public awareness and the public's more demanding stance towards the lack of action by social and political authorities. This public demand is manifested in the concept of "environmental democracy"⁵ and underlines the importance of more effective laws to protect the environment⁶.

This paper's point of view is that environmental law translates this particular evolutionary point in time into principles and rules, and highlights that given the extent and significance of the grave issues we are confronting, concepts that come from other sciences need to be dealt with carefully to ensure these are interpreted and implemented effectively⁷. As Meynier states, "law conceives its purpose thanks to conceptual instruments directly linked to environmental reality. However, concepts imply generalised, abstract facts, i.e., reality is recreated to some extent. This reality is found in concepts that do not just define something, but also convey values and a particular understanding of reality so that law can act on that reality. Thus, descriptive concepts shape a separate legal reality pertaining exclusively to environmental law"⁸.

⁵ For an introduction to this concept see J.-M. Sauvé (2010), "La démocratie environnementale", in *Conférences du Conseil d'État: La démocratie environnementale* (available at <https://www.conseil-etat.fr/actualites/discours-et-interventions/la-democratie-environnementale-aujourd-hui>).

⁶ Focussing on the issue of the effectiveness of environmental law, academic opinion echoes this requirement. See Y. Kerbrat (2019), "Effective Implementation of Environmental Law", in Y. Aguila / J. E. Viñuales (eds.), *A Global Pact for the Environment: Legal Foundations*, University of Cambridge, pp. 130-136 (available at <https://globalpactenvironment.org/>).

⁷ For a global approach to this problem in Spanish administrative law, see M. Vaquer Caballeria (2014), "La formación de conceptos en el Derecho público: un comentario", *Revista Vasca de Administración Pública*, special edition no. 99-100, pp. 3005-3023.

⁸ A. Meynier, (2014), "Le rôle des concepts dans la fondamentalisation du droit de l'environnement", in P. Milon / D. Samson, *Révolution juridique, révolution scientifique. Vers une fondamentalisation du droit de l'environnement ?* Presses Universitaires d'Aix-Marseille (PUAM), Aix-en-Provence, pp. 118.

In contrast to what are referred to as descriptive concepts, Meynier finds that environmental law contains prescriptive concepts which it uses to condense the objectives of this branch of law: "some of them constitute more or less imperative guidelines, as in the case of the following terms: "future generations", "sustainable development", "general interest", "favourable conservation status", "healthy environment". Others convey principles that shape the subject as a whole, such as the precautionary, compensation or balance principles" (*Ibid.*, p. 120).

The complete, detailed study carried out highlights the true complexity and difficulty of the work involved in building up

Therefore, the environmental lawyer who usually lacks the scientific and technological background needs to form a well-founded opinion on factual issues which are the cornerstone of the current ecological crisis. This involves dedicating a lot of time to consulting pertinent literature that deals with a wide range of matters relating to energy, biodiversity, ecology, economy, etc., in addition to carrying out direct legal research [8,9,10,11]. This article sought also to reflect that balance and to outline some of the personal conclusions reached. Given that the publications on each subject are so numerous, this paper ran the risk of becoming merely a review of literature. Inevitably therefore, the variety works consulted, which are not exhaustive, were the personal choice of the author who is also conscious of the danger—which is even greater when we step out of the comfort zone of our own specialist area—of omitting works that may be essential for gaining a better understanding of each subject area.

2. CONCEPTUAL DEVELOPMENT AND EPISTEMOLOGICAL CHANGES

It is true to say that environmental policy and legislation were not considered as important as they are today until the scientific community firmly expressed its concern at the continuing alarming rate of environmental degradation⁹. Thus, science finds itself at the very heart of environmental law with which it has a complex, dynamic relationship that goes beyond merely transcribing scientific progress into regulations. As Born and De Sadeleer point out, "the sciences on which environmental law is based are different"¹⁰.

environmental law into a coherent branch of law that increasingly contains its own concepts. The need to establish some order in the conceptual world of environmental law calls for analysis of the various unifying concepts, by successive approximations, alongside the values and organisational concepts that come from ecology or other disciplines. See A. Meynier, *Réflexions sur les concepts en droit de l'environnement*, LGDJ, Paris, 2020.

⁹ Barry Commoner is a good example of the difficult relationship between science and politics regarding environmental matters. For a biographical sketch see J. Riechmann, (2016), "Barry Commoner y la oportunidad perdida", *Encrucijadas. Revista crítica de ciencias sociales*, vol. 11, pp. 1-21.

Commoner early highlighted how the impact of modern science on public affairs has created an almost paralysing paradox. See B. Commoner, *Science and Survival*, Viking, New York, 1966.

¹⁰ See Ch.-H. Born, N. De Sadeleer [12], biographical note to the book by E. Naim-Gesbert, *Les dimensions scientifiques du droit de l'environnement — Contribution à l'étude des rapports de la science et du droit*, doctoral thesis, University

This close relationship between environmental law and the other branches of science on which it depends compels us to confront certain challenges concerning the major differences in scientific fields as opposed to the legal sector between first, aims and objectives, second, time frames for development, and finally, requirements of verifiability and evidence of its results¹¹. Scientific concepts and results often have to be translated to ensure that scientific concepts that have been incorporated into environmental law can be applied in the legal stance¹². Furthermore, a number of concepts and principles used in environmental law have both a scientific and an evaluative component¹³. In

these cases, the aim should be to differentiate the scientist's role from that of the lawyer, who should focus on the social and ethical aspects¹⁴.

This is the case, for example, with the "precautionary principle", according to which it is for the law to decide on the level of risk that society can tolerate at any given moment¹⁵. Misgivings expressed by certain sectors in industry have led to attempts to create an alternative "innovation principle" to counteract the alleged limitations that a wider interpretation of the precautionary principle could mean for technological developments and the advancement of knowledge¹⁶.

This same evaluative element, which is essential when addressing issues affecting society from a legal perspective, is also present in the definition of "ecosystem", a key concept for legislation that

of Lyon, 1997 [emphasis added], published in *Revue Juridique de l'Environnement* (no. 3, pp. 555-557).

11 On this point see J. Esteve Pardo, (2003), "Ciencia y Derecho ante los riesgos para la salud. Evaluación, decisión y gestión", *Documentación Administrativa*, no. 265-266, pp. 137-149.

12 Weis reminds us that "To help translate scientific certainty to decision-makers, advisory bodies such as the Intergovernmental Panel on Climate Change have used scales that link Bayesian-based probabilities to legally equivalent phrases such as 'beyond a reasonable doubt' or 'reasonable grounds for belief'" (cited by J. W. Moore, L. Nowlan, M. Olszynski, A. L. Jacob, B. Favaro, L. Collins, Glt.-L. Williams Davidson, J. Weitz (2018), "Towards linking environmental law and science", *FACETS—a multidisciplinary open access science journal*, vol. 3, pp. 375–391).

This call for interdisciplinary research is essential when confronting new challenges posed by advances in scientific knowledge. See D. Owen, C. Noblet (2015), "Interdisciplinary Research and Environmental Law", *Ecology Law Quarterly*, vol. 41, Issue 4, pp. 887-938.

Furthermore, epistemological prejudices - which are sometimes not exempt from purely political elements - burden the efforts made by researchers who are trying to place science at the service of sustainable development and who, with this aim, go beyond the boundaries of their respective disciplines, when there are no suitable criteria against which to evaluate such research efforts. See A. Kläy, A. B. Zimmermann, F. Schneider (2015), "Rethinking science for sustainable development: Reflexive interaction for a paradigm transformation", *Futures*, vol. 65, pp. 72-85 on the need to evaluate the sustainability of scientific and investigative activity, which must also play a part in converting scientists themselves into agents of change for environmental awareness.

13 This is the ecological basis that underpins the equilibrium paradigm in nature, which influences numerous legal regulations concerning the environment. Bosselman and Tarlock consider the evolution of this paradigm that predominated the field of ecology until the 1980s when it was abandoned in favour of a perspective based more on the dynamism and vagueness of the fields in nature, which later affected the legal perspective itself. See F. P. Bosselman, A. D. Tarlock [13], "The Influence of Ecological Science on American Law: An Introduction", *Chicago-Kent Law Review*, vol. 69, pp. 847-873 (available at https://scholarship.kentlaw.iit.edu/fac_schol/107).

These authors believe that "... the adoption of ecology as the ground norm of environmentalism and environmental law bears close examination because of dramatic changes in

ecology since its initial incorporation into environmental law" (*ibid.*, p. 864).

See Meynier, *op. cit.*, pp. 144-150 on the concept of biological equilibriums and their gradual disappearance from positive environmental law in France.

14 When trying to initiate the dialogue that is needed between areas of science and knowledge that are very different from each other, and in turn, to enable decision-making in strongly participatory contexts, the concept of "internormativity" (interplay between different normative systems) is useful. The term was coined by Carbonnier to try to explain the relationship between law and morality but was increasingly used in the environmental field. Cf. A. POMADE (2012), "Penser l'interdisciplinarité par l'internormativité. Illustration en droit de l'environnement", *Revue interdisciplinaire d'études juridiques*, 2012,1, vol. 68, pp. 85-106.

15 However, the precautionary principle does not just apply in the context of environmental law. It is used in a much wider context and includes situations where scientific information is insufficient, inconclusive or uncertain, and where a preliminary objective scientific evaluation shows effects that may be damaging for the environment and for human, animal or plant health, or potentially incompatible with the high level of protection that is required under the current legal system. In Spanish academic opinion, see the studies by C. Cierco Seira, [14], "El principio de precaución: reflexiones sobre su contenido y alcance en los derechos comunitario y español", *Revista de Administración Pública*, no. 163, pp. 73-126; G. Doménech Pascual [5], *Derechos fundamentales y riesgos tecnológicos: el derecho del ciudadano a ser protegido por los poderes públicos*, Centro de Estudios Políticos y Constitucionales, Madrid; A. E. Embid Tello [16], "El principio de precaución", in J. A. Santamaría Pastor (Ed.), *Los principios jurídicos del Derecho Administrativo, La Ley, Madrid*; and, among more recent works, B. Soro Mateo (2017), "Construyendo el principio de precaución", *Revista Aragonesa de Administración Pública*, no. 49-50, pp. 87-151.

16 This principle is articulated on the European Risk Forum website <<http://www.riskforum.eu/>>, [Last accessed: 17/04/2019]. The attempt to embed this principle in European Union Law has come to nothing in view of the "principle of non-regression" emergency. See Introduction above.

protects nature and biodiversity¹⁷ and whose conceptualisation is being reviewed in scientific fields. For an environmental lawyer it is essential to translate the ecosystem's functionality and complexity into effective tools to be used in decision-making processes and natural resources and land management.

3. THE JOURNEY FROM THE CONCEPT TO ITS ACTUAL USE: EVOLUTIONS

3.1 From "Risk" to "Essential Use"

There are some general concepts that stand out on the overall perspective which law then uses to deal with the protection and conservation of the environment. In this case, the concept of "risk" certainly permeates all modern studies on the subject¹⁸, and where natural risks are concerned, some authors have even come up with their own label to group the various disciplines dealt with in their study into one field of knowledge¹⁹.

The toxic effects of pesticides are a much-debated topic about which businesses in the sector use a number of convincing methods to strongly defend the virtues of their products. Their potential adverse effect on the environment

and on humans needs to be carefully examined and, if possible, identified²⁰. In its judgement of 6 May 2021 on the Bayer case (case C-499/18 P. Rapporteur: Bay Larsen), the Court of Justice of the European Union (First Chamber) points out that "The precautionary principle means that where there is uncertainty as to the existence or extent of risks, including risks to the environment, protective measures may be taken without having to wait until the reality and seriousness of those risks become fully apparent. Where it proves to be impossible to determine with certainty the existence or extent of the alleged risk, because the results of studies conducted are inconclusive, but the likelihood of real harm to the environment persists should the risk materialise, the precautionary principle justifies the adoption of restrictive measures" (Para. 80)²¹.

In the current context of the global pandemic and the climate crisis, the concept of risk should play a stronger role when protecting environmental assets²². Furthermore, the growing recognition that the risk assessment approach to analysing potential hazardous substances and their alternatives is neither efficient nor practical calls for a proposal to control these substances by

¹⁷ Section 3(10) of the Spanish Natural Heritage and Biodiversity Act of 13 December 2007 (Ley 42/2007, de 13 de diciembre, del Patrimonio Natural y de la Biodiversidad) defines "ecosystem" as a "dynamic set of plant, animal and microorganism communities and their non-living environment that interact as a functioning unit".

Section 2 of the Act is frequently cited as being one of principles that gave rise to the law, namely, paragraphs a) ("Maintaining essential ecological processes and basic vital systems, supporting ecosystem services for human welfare..."), c) ("The organised use of resources to ensure the sustainable use of natural heritage, and in particular, of species and ecosystems, their conservation, restoration and enhancement, and to prevent net biodiversity loss" and d) ("The conservation and safeguarding of the variety, uniqueness and beauty of natural ecosystems, geological diversity and the countryside...").

¹⁸ There is an impressive summary of the legal implications of this concept in J. Esteve Pardo [17], "El Derecho del medio ambiente como derecho de decisión y gestión de riesgos", *Revista electrónica de Derecho-Universidad de La Rioja (Redur)*, vol. 4, pp. 7-16.

Esteve's comment on the phenomenon of retraction, or shrinking, as he also calls it, of the law due to the technological complexity and uncertainties it creates about risks is particularly relevant: "unless we find a solution, environmental law is going to become an anomie branch of law, a branch of law without rules, a branch of law whose regulations are important on a strictly formal, procedural level" (*Ibid.*, p. 16).

¹⁹ Cf. J. Olcina Cantos (2008), "Cambios en la consideración territorial, conceptual y de método de los riesgos naturales", in *Diez años de cambios en el mundo, en la geografía y en las ciencias sociales, 1999-2008, X Coloquio Internacional de Geocrítica*, 26-30 May, Barcelona (available at <https://www.ub.edu/>).

²⁰ Cf. B. Soro Mateo (2018), *Derecho de los pesticidas*, Tirant Lo Blanc, Valencia.

With regard to the risks these products represent specifically to groundwater, see S. M. Álvarez Carreño [18], "Actividad agrícola y contaminación de aguas subterráneas: régimen jurídico", in A. Embid Irujo (Ed.), *Agua y agricultura*, Thomson, Civitas, Cizur Menor, pp. 215-281.

With regard to the active substance Glyphosate, CJUE case law has upheld that the risks it poses call for the precautionary principle to be implemented and that other intellectual property rights or industrial secrets rights will not prevail when it comes to allowing access to information contained in toxicity and carcinogenicity studies.

See Á. Osorio Sierra (2015), *La aplicación del principio precautorio en el control de legalidad de los actos administrativos. La protección judicial del ambiente frente a las aspersiones de glifosato al interior de los parques nacionales naturales*, Universidad Externado de Colombia, Bogotá (available at <https://bdigital.uexternado.edu.co/handle/001/2347>) on the specific issues in Colombia regarding the use of this substance.

²¹ See, to that effect, judgment of 1 October 2019, *Blaise and Others (C-616/17)*, Rapporteur: Bay Larsen), paragraph 43 and the case-law cited.

²² For Donati, the current climate crisis and the pandemic caused by the coronavirus indicate the high degree of interdependency our societies have reached as a result of globalisation, to the extent that production, transport and consumer chains are not only bigger, but they have also become global risks. This situation calls for a better coordinated strategy both nationally, and particularly, at EU level. Cf. A. Donati [19], "Climate Change and Pandemics: The EU Risk-Management Strategy Under Scrutiny", MPILux Research Paper Series, 2020 (4) (available at www.mpi.lu).

categorizing their function and use in society alongside the risk that they may pose, that is by exploring and promoting the concept of “essential use” as a new regulatory tool²³.

3.2 Other Sociological, Technical or Economics-based Concepts

Examples of other concepts found in environmental law texts, associated more with sociological fields, include “vulnerability”²⁴, “globalisation”²⁵ (which also has a strong economics-based focus), and the concept of “governance”²⁶ which stems from political science. While some are purely technical concepts linked to the fight against emissions,

such as “best available techniques (BAT)”²⁷ or “generic reference values”, others, such as “environmental footprint”²⁸, have been created to measure the impact that the specific use of natural resources has on the environment.

In short, numerous other terms — “threshold”²⁹, “resilience”, “ecosystemic”, “holistic”, etc. — are found in legal academic opinion and in legal texts and judicial decisions, thus proving the constant influx of terms from natural sciences and human sciences into environmental law, where they acquire special meanings that are sometimes far removed from the original branch of science that forged them [22,23].

Many of them have been shaped from the need to go beyond the foundations of a classic liberal orthodox economic theory that has no instruments to internalise environmental costs, according to which the economic operator concerned pays for the pollution or environmental damage they cause, thereby incorporating this variable into their production costs³⁰. Hence the origin of such fundamental

²³ See K. Kathleen Garnett / G. Van Calster, “The Concept of Essential Use: A Novel Approach to Regulating Chemicals in the European Union”, *Transnational Environmental Law*, 10:1 (2021), pp. 159–187.

See also N. de Sadeleer, *Environmental Principles. From Political Slogans to Legal Rules*, second edition, Oxford University Press, New York, 2020, pp. 135-361.

²⁴ See B. Soro Mateo, J. Jordano Fraga, J. F. Alenza García (eds.), *Vulnerabilidad Ambiental y Vulnerabilidad Climática en Tiempos de Emergencia*, Tirant lo Blanch, Valencia, 2020.

²⁵ This was already an emerging theme some decades ago which means a vast amount has been written about the effects of globalisation on law: a scholarly perspective in J.-B. Auby, [20], *La globalización, el Derecho y el Estado*, Global Press, Sevilla; a summary of different tendencies in E. Guichot (2012), “Globalización jurídica y Derecho público. Recientes aportaciones en la doctrina europea”, *Revista de Administración Pública*, no. 187, pp. 305-326.

With regard to administrative law, see B. Marcheco Acuña (2018), “Los desafíos de la ciencia del Derecho administrativo ante la globalización”, *Revista General de Derecho Administrativo*, no. 49 (available at <http://laadministraciondiala.inap.es/>); and for Spanish internationalist academic opinion see J. Juste Ruiz (2012), “El Derecho internacional frente a los desafíos ambientales globales”, in E. J. Pérez Alonso, E. Arana García, J. L. Serrano Moreno, P. Mercado Pacheco (co-ord.), *Derecho, globalización, riesgo y medio ambiente*, Tirant lo Blanch, Valencia, pp. 119-142.

²⁶ Challies and Newig define environmental governance as “the totality of interactions among societal actors aimed at coordinating, steering and regulating human access to, use of, and impacts on the environment, through collectively binding decisions. Environmental governance arrangements may be directed towards a range of causes – including conservation and environmental protection, spatial and land use planning, (sustainable) management of natural resources, and the protection of human health – and operate across scales to address local and global environmental problems” (E. Challies, J. Newig, “What is ‘environmental governance’? A working definition” (available at <https://sustainability-governance.net/>).

An example of how this concept is used specifically in relation to the management of protected natural spaces is found in J. L. Bermejo Latre [21], “La participación del público en la protección de la biodiversidad”, in G. García-Álvarez (Ed.), *Instrumentos territoriales para la protección de la Biodiversidad*, de la Revista Aragonesa de Administración Pública —Monografías, XVI, 2016, pp. 151-176.

²⁷ I. Revuelta Pérez (2019), “«Mejores técnicas disponibles»: Un singular sistema de regulación ambiental” *Revista catalana de Dret Ambiental*, vol. 10, no. 1, pp. 1-34.

²⁸ A. Nogueira López (2019), “La huella ecológica. El establecimiento de indicadores ambientales y su significación para el Derecho”, *Revista catalana de Dret Ambiental*, vol. 10, no. 1, pp. 1-25.

A specific example of this is “water footprint”, the term used to describe the relationship between direct and indirect water consumption and water pollution processes. As Ivanova, Sarmiento and Domínguez remind us, the term was introduced in the 1990s by Arjen Hoekstra of UNESCO-IHE, who used it to assess the dynamics of water to indicate pressure on water resources. The term is understood to mean “freshwater use that looks at both direct and indirect water use of a consumer or producer”. (Hoekstra, 2004). According to Hoekstra, the water footprint has three components depending on the source of water used to satisfy water requirements for one purpose or another. Blue water footprint refers to the use of water that has been sourced from surface or groundwater, green water footprint refers to water from precipitation, and grey water footprint is the amount of water needed to neutralise the concentration of pollutants discharged into a water resource (Y. Ivanova, A. Sarmiento López, E. A. Domínguez Calle (2016), “Evaluación de la huella hídrica de la ciudad de Bogotá como una herramienta de la gestión del agua en el área urbana”, in D. A. Cardona Zea, I. Restrepo Tarquino (Comp.), *Manejo del riesgo en la gestión del agua. Retos ante los riesgos ambientales en el ciclo del agua, justicia ambiental y conflictos*, Programa Editorial Universidad del Valle, Cali, p. 92).

²⁹ For an analysis of this concept see PEYEN, L. (2014), “Essai d’une approche épistémologique du seuil en droit de l’environnement”, en MILON, SAMSON, Op. cit., pp. 133-152.

³⁰ This new economic model becomes reality in 1920 with the introduction into economics theory of the concept of “negative externalities” by the economist Albert Cecil Pigou in *The Economics of Welfare*. As Lozano reminds us, “up until the middle of the last century, conventional economics had

concepts in environmental law as “sustainable development” and “sustainability”³¹.

More recently, concepts such as the “circular economy”³², “the economy for the common good”, or lastly, the “green economy”³³, and even “sustainable bioeconomy”³⁴, are exerting

ignored the environmental variable in decision-making, since nature appeared to be able to provide an inexhaustible supply of natural resources and to receive endless emissions and pollution waste. But as the signals indicating that shared or “free” assets were becoming scarce or deteriorating became clearer and more obvious, and they were increasingly scientifically proven (river and water sources pollution; waste and emissions that are harmful to health, rapid biodiversity loss any much more), it was evident that the model needed to change” (Lozano, “Derecho ambiental...”, Op. cit., p. 415).

It is true that for many years now, economics has been drafting instruments to measure the effects of environmental regulations that contradict natural opposition between environmental restrictions and economic growth. See the reference to the theory known as “Porter hypothesis” — countries adopting a stringent environmental regime should not be afraid that this endangers their competitive position, since the evidence shows that this may speed up economic growth rather than retard it— which reinforces the “environmental Kuznets curve (EKC)”, in M. Faure (2012), “Effectiveness of Environmental Law: what does the evidence tell us”, William & Mary Environmental Law and Policy Review, vol. 36, no. 2, pp. 293-336 (available at <https://scholarship.law.wm.edu/wmelpr>).

The contribution made by economic theory to the protection of the environment was reinforced when the American economist William D. Nordhaus was awarded the Nobel Prize in 2018, insofar as his attempt to integrate climate change into economic models is acknowledged at the highest level in what is known as “Climate Economy”.

³¹ Cf. J. F. Alenza García [24], “Desarrollo sostenible”, in J. A. Santamaría Pastor (Ed.), *Los principios jurídicos del Derecho Administrativo, La Ley, Madrid*, pp. 1387-1426.

³² Cf. R. J. Santamaría Arinas (2019), “Economía circular: líneas maestras de un concepto jurídico en construcción circular”, *Revista catalana de Dret Ambiental*, vol. 10, no. 1, pp. 1 – 37 (available at <https://revistes.urv.cat/index.php/rcda/article/view/2567/2551>)

³³ PNUMA (2011), *Hacia una economía verde. Guía para el desarrollo sostenible y la erradicación de la pobreza* (available at <http://sostenibilidadyprogreso.org/files/entradas/hacia-una-economia-verde.pdf>).

³⁴ Decision No 1386/2013/UE of the European Parliament and of the Council of 20 November 2013 on a General Union Environment Action Programme to 2020 states: “Employment in environmental technologies and service sectors in the Union has been growing by around 3 % annually over recent years. The global market for eco-industries is estimated to be worth at least one trillion EUR, and is forecast to almost double over the next 10 years. European companies already have a global lead in recycling and energy efficiency and should be encouraged to benefit from this growth in global demand, supported by the Eco-innovation Action Plan. For example, the European renewables sector alone is expected to generate more than 400 000 new jobs by 2020. A sustainable bioeconomy can also contribute to intelligent and green growth in Europe, and, at the same time, it will benefit

influence on this attempt to go beyond an aggressively capitalist economic model. In reality, it is this attempt to ensure that the positive or negative effects of specific consumption actions or decisions are taken into account that lies behind many of the new concepts that populate studies and reports, infiltrate the soft law of international institutions and from there, end up being used in actual regulations or judicial decisions. In any event, academic opinion, is mindful of concepts such as “virtual water”, “ecosystem services”³⁵ and lastly, “Nature-based solutions (NBS)”³⁶.

Concepts that are derived from technological advances also have legal implications as they pose challenges that need to be addressed in law. At the time of its inception, this was the case with “biomass” (Martín Mateo), and more recently with “fracking”³⁷ or anything relating to the use of new technologies that is classified as “smart”³⁸.

from improved resource efficiency” (quoted by Lozano, Op. cit. p. 413, n. 6).

³⁵ Cf. M. Monteduro (2013), “Environmental Law and Agroecology. Transdisciplinary Approach to Public Ecosystem Services as a New Challenge for Environmental Legal Doctrine”, *European Energy and Environmental Law Review*, vol. 22, Issue 1, pp. 2–11; K. Mertens, A. Cliquet, B. BANHEUSDEN (2012), “Ecosystem Services: What’s in it for a Lawyer”, *Energy & Environmental Law Review*, vol. 21, pp. 31 and following.

*This concept is linked to “natural capital” which arises from the attempt to assess nature in monetary terms. Cf. R. Costanza, R. De Groot, L. Braat, I. Kubiszewski, L. Fioramonti, P. Sutton, S. Farber, M. Grasso [25], “Twenty years of ecosystem services: How far have we come and how far do we still need to go?”, *Ecosystem Services*, vol. 18, pp. 1-16 (available at <https://www.robertcostanza.com/>).*

³⁶ The United Nations World Water Development Report 2018 states that nature-based solutions (NBS) “are inspired and supported by nature and use, or mimic, natural processes to contribute to the improved management of water. An NBS can involve conserving or rehabilitating natural ecosystems and/or the enhancement or creation of natural processes in modified or artificial ecosystems”. Cf. S. Perales Momparler, *Soluciones basadas en la naturaleza para la gestión del ciclo urbano del agua* (available at <https://www.camarazaragoza.com/>).

³⁷ See G. Valencia Martín, J. R. Rosa Moreno (Eds.) (2016), *Derecho y “Fracking”*, Thomson Reuters, Aranzadi, Cizur Menor.

³⁸ Cf. R. Martínez Gutiérrez (2017), “El impacto de las «smart cities» en la tutela ambiental y en la planificación urbana”, in PIÑAR MAÑAS, J. L. (Ed.), *Smart Cities: derecho y técnica para una ciudad más habitable*, Editorial Reus, Madrid, pp. 53-72.

*With regard to water, the term “smart water” is used to describe technology-based water quality monitoring systems that are becoming more important with advances in communication technologies. For a detailed perspective on the latest technological innovations in this field, including suggestions for cheaper and less complex control systems, see S. Geetha, S. Gouthami (2017), “Internet of things enabled real time water quality monitoring system”, *Smart Water—International Journal for @qua*, 2 :1.*

Another group of concepts originates from what has undoubtedly become a key concept that is central to any discussion on the environment and is the focus of political and legal concerns, namely, "climate change"³⁹. In turn, it has led to the creation of "climate refugee"⁴⁰, "climate justice"⁴¹ and even a term to define a new climatic age, "the Anthropocene Epoch"⁴². It is safe to assert that, in establishing that anthropic activity attributes to changes in the climate, the underlying tension between science and politics,

in other words, between scientists and politicians, has been taken to its extreme⁴³.

4. IS SCIENTIFIC UNCERTAINTY TO BLAME FOR ENVIRONMENTAL LAW'S LACK OF EFFECTIVENESS?

A certain degree of scientific uncertainty and conceptual controversy is usual in the world of scientific research. Intense debate about, and criticism of, contradictory, or at least diverging, stances are the norm. However environmental law is bound by legal reasoning whose ultimate aim is to provide practical solutions to a conflict of interests in society. Such stances are a source of weakness. Law must decide whether it fully accepts, or conversely, declines to introduce into regulations concepts or principles that are to subject to a deep scientific debate.

Those opposing to effectiveness of environmental law use sometimes that dependency and doubt as a smokescreen for their profitable harming actions.

5. FINAL THOUGHTS: THE LAWYER IN HIS LABYRINTH

To achieve a more balanced assay of the complex interactions between scientific, political, economic and legal fields, would require extensive, cross-disciplinary research to be able to compare the results obtained from research on science history with those from epistemology and ecology, all of which would be conducted with a thorough knowledge of positive law and its interpretation in case law.

The dialectic contrast of environmental law as a branch of the legal system with the requirement deriving from scientific rationality and objectivity would make it possible to conceptualise and define the contributions gained from such extensive and varied knowledge. If such research was feasible, it would possibly conclude that both the glow and the relative dimness of environmental law is due to the herculean challenge it faces to find the value of what is fair in fields where lack of determination, lack of absolute certainty and the complexity of the tense interplay between powerful conflicting

³⁹ See M. Torre-Schaub (2019), "La construcción del régimen jurídico del clima entre ciencia, derecho y política económica", *Revista catalana de Dret Ambiental*, vol. 10, no. 1, pp. 1-35.

⁴⁰ According to authors who have defined the term, environmental refugees or climate refugees are "Those people who have been forced to leave their 'natural environment', temporarily or permanently, because of a marked environmental disruption, either due to natural dangers and/or caused by human activity, [...] that has placed their existence at risk and/or seriously affected their quality of life". Cf. S. Borràs Pertinat [26], "Refugiados ambientales: el nuevo desafío del Derecho internacional del medio ambiente", *Revista de Derecho*, vol. 19, no. 2, pp. 85-108.

The need to find an adequate definition for this situation that is linked to the particular vulnerability of certain populations or groups of people is already stated in MYERS, N. (1995), *Environmental Refugees*, Climate Institute of Washington D. C., 1995, p. 17 and following.

⁴¹ See M. Torre-Schaub, "Le contentieux climatique, quel apport en termes de droits", in *Colloque annuel de la SFDE*, Aix-en-Provence, 30 June 2017; and, "Justice et justiciabilité climatique", *Ecole d'été Autour de 2^e Université de Grenoble*, Autrans, 12-16 June 2017.

⁴² SANZ LARRUGA points out that the term "Anthropocene" had been popularised in 2000 by Paul Crutzen, Nobel Prize winner in chemistry, to mean that we find ourselves in a new time period characterised by the impact caused by human activity on the Planet's ecological processes. In fact, we had been talking about humans' capacity to profoundly influence the Earth's physical geography long before this. A case in point is the American diplomat George Perkins Marsh who condemned the degrading anthropic effects on the environment in his pioneering work "Man and Nature" (1864). Much more recently, in the first decade of this century, the highly prestigious Geological Society of London and the International Commission on Stratigraphy acknowledged and even defined this new geological time period. This stance on the new geological era brought about by humans has not been without its critics for whom it is more of a political statement than a scientific approach. See J. Sanz Larruga, "¿Bienvenidos al Antropoceno?", in his blog *Ambientalycual* (available at <http://blogs.lavozdeg Galicia.es>).

These new questions in an age that is plagued with uncertainties mean there is a need for a new legal paradigm to address the challenges of this new era. See L. J. Kotzé (2020), "Earth system law for the Anthropocene: rethinking environmental law alongside the Earth system metaphor", *Transnational Legal Theory*, vol. 11, nos. 1-2 (*Transnational Environmental Law in the Anthropocene*), pp. 75-104.

Among Spanish legal-philosophical academic opinion, see T. Vicente Giménez, C. Berzosa Alonso-Martínez (co-ord.) (2016), *Justicia ecológica en la era del Antropoceno*, Trotta, Madrid.

⁴³ See D. French, B. Pontin (2016), "The science of climate change: a legal perspective on the IPCC", in D. A. Farber, S. Sato (Eds.), *Climate change law*, *Elgar Encyclopedia of Environmental Law*, vol. 1, Edward Elgar, Cheltenham, pp. 9-19.

interests, prevail⁴⁴. Naim-Gesbert detects real tension between “scientific truth” which derives from the order of things, and “legal truth” which comes from the legal system. For this author, the purpose of the environmental system is two-fold: effective protection of the environment and remodelling society with regard to environmental imperatives. Here the multiple truths become an actual “science policy”, i.e. a policy attached to a democratic field. Law falls from its pedestal. It is no longer the bearer of a single discourse on the truth, but instead acts as a mediator between science and culture which are constantly being redefined.

This characteristic also marks the extent to which legal environmental laws are effectively implemented. This effectivity is also determined by society’s overall level of acceptance and support of the mandates deriving from environmental law. By establishing that anthropic activity is the cause of global warming, Cook et al. point out that society’s perception of the degree of scientific consensus about this cause is an essential requirement for supporting policies to mitigate the effects of climate change. However, there is a significant difference between public perception and reality, since 57 % of US citizens either disagree with or are simply unaware of the overwhelming scientific consensus that the earth is heating up because of human activity⁴⁵. Lozano follows the same reasoning and points out that “society uses law to address challenges and dilemmas throughout history. According to scientists, the issue addressed by environmental law is the anthropic destabilisation of the biosphere: as a result of the driving forces activated by the industrial revolution (economic grow, population explosion – human population tripled in the twentieth century and United Nations population forecasts

predict that world population will reach 9,600 million by the end of this century - , extensive use of fossil fuels, mass consumption), the accumulative and synergetic effect of an infinite number of environmental needs and impacts have caused the destabilisation of the biosphere’s support functions, and the scientific community is adamant the risk of an irreversible change is certain”⁴⁶.

CONCLUSION

Environmental law studies demonstrate that there is a line of force based on fluid, fruitful dialogue between different fields of knowledge. Law, moreover, must respond to participatory- and democratic-based agreements about the degree of environmental protection each society wants in order to guarantee the quality of life it considers appropriate or necessary at any given time⁴⁷. The search for rationality and objectivity in a legal discipline such as environmental law must necessarily consider both the dependency from other sciences related to physical environment, their components and interactions, and the social factor⁴⁸. A lengthy, complex debate about the type of scientific knowledge needed as the basis of legal regulations is influenced by powerful interests which, at this particular stage of the necessary ecological transition of the economic and social systems, handle vast resources to guide regulatory developments towards better protection of their interests. Lawyers are aware of the achievements made in environmental law, as well as its manifest deficiencies and

⁴⁴ Naim-Gesbert, *Dimension scientifiques...*, quoted by Born, Sadeleer, *Op. cit.* p. 557.

⁴⁵ J. Cook, D. Nuccitelli, S. A. Green, M. Richardson, B. Winkler, R. Painting, R. Way, P. Jacobs, A. Skuce [27], “Quantifying the consensus on anthropogenic global warming in the scientific literature”, *Environmental Research Letters*, vol. 8, p. 6.

Campaigns designed to confuse the public about the level of agreement among climate scientists contribute to this distance between reality and society’s perception. Accordingly, these authors point out that in 1991, Western Fuels Association conducted a communications campaign worth \$510,000 whose intention was to “reposition global warming as theory (not fact)”. A key strategy that was used involved creating the impression that there was an active scientific debate by using dissident scientists as spokespeople. The situation was exacerbated in media coverage since protocol requires that opposing parties are given the same amount of exposure. In practice this means a minority can strengthen its points of view. Although the situation seems to have improved in highbrow media in both the United Kingdom and the United States, the United Kingdom’s tabloids have shown no signs of improving their reporting of these matters since 2006 (*ibid.*).

⁴⁶ Lozano Cutanda, “Derecho ambiental...”, *Op. cit.* p. 410.

⁴⁷ The decision about which type of environmental regulations are appropriate is always characterised by alternatives between the command-and-control approach or by market-oriented solutions, or by the more convenient combination of both regulatory techniques. Cf. A. Blackman, Zhengyan Li, A. Liu, [28], “Efficacy of Command-and-Control and Market-Based Environmental Regulation in Developing Countries”, *Annual Review of Resource Economics*, 2018, vol.10, pp. 381-404.

⁴⁸ Very interesting reflections on the complex interaction between risks, economic interests, scientific uncertainties and the need for politicians to take decisions so as to prevent potential damage to democratic societies are available in the EUROPEAN ENVIRONMENTAL AGENCY (EEA), *Environmental Issue Report n° 22: Late lessons from early warnings: the precautionary principle 1896–2000*, Office for Official Publications of the European Communities, Luxembourg, 2001.

The report highlights that society’s acceptance of risks deriving from economic activities require them to take part in making the decisions that create those risks and the means of managing them. An adequate policy where environmental issues are concerned, does not only need objective scientific knowledge, but also has to clearly state the ethical options that are at stake in each decision.

limitations, and, just like Theseus who momentarily loses the golden thread offered by the bold Ariadne, they must find a way out of that labyrinth.

COMPETING INTERESTS

Author has declared that no competing interests exist.

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