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WHY AND HOW SHOULD WE FIND METHODS, REASONS AND PROCEDURES FOR SCIENCE BASED POLICY MAKING IN COPING WITH CLIMATE CHANGE?

1. Introduction

In a context of polycrises - ranging from the pandemic to the biodiversity collapse, the climate emergency, democratic backsliding, and the widespread diffusion of misinformation - the relationship and modes of exchange between scientific knowledge, law, and political decision-making become critically important. This is all the more true if we think that the crises mentioned above are often described as “wicked problems”, complex challenges that lack straightforward or definitive solutions and require grappling with uncertainty as well as adopting forms of adaptive governance. In this framework, different forms of knowledge can contribute to designing possible solutions. Especially in matters of environment and health, science and law inevitably intersect, shaping and hybridizing one another — sometimes in unexpected ways — and calling for a holistic approach, as embodied in the “One Health” paradigm.

This relationship between science and law is, however, not easy: tensions often arise (and are justified) on the grounds of the different nature of the two domains. Scientific knowledge is traditionally descriptive, concerned with understanding and explaining the world, whereas the language of law is prescriptive, focused on setting norms and guiding behavior. Moreover, the different disciplines tend to make different use of methodologies, goals, temporalities, and even languages.

As suggested by Tallacchini, the evolution of the science-law relationship has evolved a lot lately, and it could be now framed in terms of “mutual legitimation”. Indeed, it is often the case that political actors seek to validate unpopular choices by delegating responsibility to science, thereby removing public decisions from democratic deliberation. The same happens on the other side too, when the normative interventions and the types of science codified by the law become the “certified”, “exact” science, somehow excluding other, alternative forms of scientific knowledge.

In the academic and philosophical debate, this has sparked a divide: some see the law as simply and neutrally science-based, while others argue that the law (and lawmakers!) actively select the type of science that mostly aligns with public objectives - setting the basis for the so-called “policy-related science”.

What several scholars have pointed out, however, is that despite the growing demand for regulations to be grounded in solid scientific knowledge, there is often little critical scrutiny of the origins and nature of that knowledge, which leads to a near-invisibility and lack of differentiation among sources. In this context, scientific knowledge becomes less a tool for validation (of the suggested policy options) and more an instrument of authority and legitimacy. In other words, the production of scientific knowledge goes hand in hand with the production of power and the organization of social life (Montanari, 2006), and is therefore far from neutral.

As researchers in the science-policy interface, this raises a number of key questions: Why is it necessary to develop methods and procedures to create science-based policies? In what ways does this approach benefit policymakers?

Addressing these questions requires a closer look at how science interacts with the law - how it enters legal frameworks with its own languages, methods, and values, and how legal discourse translates, interprets, and legitimizes scientific claims. Specifically, we aim to explore the mutual shaping of these two domains: how science, as a dynamic social institution, influences legal norms and processes, and how the law, in turn, determines what counts as legally relevant science, who is recognized as a credible expert, and how scientific data should be understood and used.

As part of the Cop-Scipo project, we tried to contribute to the development of the debate on the relationship between science and law in the specific context of climate change adaptation measures. Within the Milan Unit, we focused on a central question emerging when analyzing the science-policy interface: are policymakers under a legal obligation to adopt specific procedures that ensure the integration of scientific data and arguments into decision-making on climate change? If so, what are the sources and institutional configurations that support such duties?

2. The Domestic Legislator and the Use of Scientific Data in Policy-Making

The correlation between worsening climate conditions and industrial activities, as well as between climate change and the exercise of fundamental rights, requires policymakers to engage with scientific data when regulating climate issues. Yet, this dialogue between science and law presents challenges, not least because of the differing paces at which the two domains evolve: while climate science is inherently uncertain and continuously evolving, the law, by its very nature, must offer stable answers over time.

As mentioned above, one of the key questions that arises in this field concerns the selection of scientific data to support legislation, as not all studies necessarily lead to the same conclusions and the choice of which expertise to rely on for decision-making is inherently not neutral. In essence, this issue revolves around the question of “whose science” (Zhu, Fan, 2024), requiring the establishment of clear criteria in advance for the inclusion or exclusion of specific expertise and scientific studies.

A second critical aspect in this discussion concerns the methods and extent of involvement of technical-scientific advisory bodies. This includes not only the range of powers granted to such bodies (the mandate given by the legislator) but also the criteria guiding the appointment of their members. Indeed, in our democratic societies, it is essential to ensure transparency in the appointment of technical-scientific advisory bodies from the outset, as well as to establish a framework that guarantees public access both to the conclusions and recommendations made by these bodies and to information on how such inputs are used by the legislative authority.

2.1 The Italian case. The Constitutional Court's Directions to the Legislator on the Necessary Integration of Science and Law

These issues fall within the framework of constitutional law, as the relationship between science and law intersects with various principles of modern constitutionalism. The Italian constitutional framework well demonstrates it, since the obligation to duly consider the scientific method in the creation of legal norms can be inferred from the jurisprudence of the Constitutional Court itself.

According to some scholars (Servetti, 2019), the Italian Constitutional Court elaborated the constitutional principle of “scientific reserve”. This principle imposes a “modal” obligation (D’Aloia, 2011) on the legislator when regulating areas characterized by technical and scientific complexity. If, in addressing such matters, the legislator fails to engage in dialogue with national or supranational authorities possessing the relevant expertise, the resulting legislative act may be deemed unconstitutional for lacking “scientific reasonableness” (Casonato, 2016). A landmark case in this regard is decision no. 282/2002, which states that the regulation of medical practice requires more than political discretion; it demands a thorough review of the relevant scientific state of the art.

These requirements are fully applicable to climate regulation, which likewise requires continuous engagement with scientific knowledge. The principle of “scientific reserve” is, however, not easy to apply. First and foremost, verifying the current state of scientific knowledge and experimental evidence - on which legislative choices should be based - often clashes with elements of uncertainty that are, to some extent, insurmountable. The inherent uncertainty of scientific knowledge makes it impossible to conceive of science as being capable of “speaking truth to power” (Wildavsky, 1979). Awareness of this reality can then lead to the development of a kind of “uncertainty intolerance” (Lazarus, Funtowicz, 2023), which risks driving the political decision-maker either toward paralysis or toward inadequate solutions (for example, excessively precautionary measures). Nonetheless, “only the full acknowledgment of uncertainty is the starting point for a way of using scientific knowledge that can restore institutional credibility” (Tallacchini 2023). Therefore, the difficult task facing legislators is to seriously and diligently engage in acquiring the available scientific data and evidence at a given historical moment, while remaining aware that such knowledge is provisional and potentially subject to revision. Politics, in this light, cannot avoid undertaking delicate risk-benefit assessments. A further source of complexity that hinders the straightforward application of the “scientific reserve” concerns the identification of the institutions and bodies, typically national or supranational, that the political decision-maker should consult. The question of what requirements scientific advisory bodies should meet (who should compose them, through what appointment mechanisms, and with what guarantees of impartiality, etc.) is still an evolving area of reflection in Italy. This intersects with the broader issue of striking a proper balance between the role of science and the scope of political discretion in public decision-making. Cop_Scipo aims at fostering dialogue on these critical points.

The necessity of establishing procedures and methods for integrating science into public policies is not only emphasized by the Constitutional Court but also by supranational bodies, particularly the European Union. The EU plays a leading role in shaping climate mitigation and adaptation policies, requiring member states to adopt strategies aligned with the European Green Deal and the goals of the Paris Agreement.

3. The European Union's Guidance to the Legislator on the Necessary Integration of Science and Law

At the EU level, the obligation to ground policymaking in scientific evidence can be found primarily in: Article 114(3) TFEU, which requires that when EU institutions legislate on internal market matters involving public health, safety, or the environment, they must take account of “any new development based on scientific facts”; and in Article 191(2) TFEU, which codifies the precautionary principle and the necessity to engage with scientific uncertainty in a procedurally rational manner, balancing scientific risk assessments with adequate decision-making.

This procedural demand is further reinforced by the Better Regulation framework (first adopted in 2015, then updated in 2021), a set of principles and tools elaborated by the EU Commission with the aim of ensuring that all legislative instruments reach the chosen objectives in the most efficient way. Among the tools identified, particular importance is given to ex-ante impact assessments, ex post fitness checks and evaluations, as well as stakeholders consultations (the latter based on Art. 11 TEU). The 2021 Guidelines suggest that such principles and tools do not wish to reach or suggest one particular solution, but they are a “way of working that allows political decisions to be prepared in an open and transparent manner, informed by the best available evidence, including via the comprehensive involvement of stakeholders”. Put differently, the attempt of the Commission with the Better Regulation framework was to codify methods and procedures for integrating science into policymaking, thereby functioning as a quasi-constitutional procedural norm.

In the European landscape, then, task forces, science advice mechanisms, expert committees, and independent advisory bodies designed to translate scientific knowledge into policy-relevant insights have started to proliferate, not simply acting as external consultants but as co-producers of law, translating scientific knowledge into policy-relevant insights. Yet the operationalization of such tools is not without challenges: for example, stakeholders engagement can at times be so uneven, and ex post evaluations are not always fully utilized.

As some scholars have underlined, indeed, evidence-based policy is not necessarily only just about efficiency, but it contributes to redefining the legitimacy of public action in democratic systems in particularly controversial issues.

3.1 Science and Law in the European climate strategy

The European Union has built its climate strategy on a science-based approach, wherein scientific evidence informs decision-making at a subsequent stage to support one choice over another (as opposed to a science-driven approach). The European Climate Law (Regulation (EU) 2021/1119) establishes the obligation for member states to implement measures consistent with climate neutrality by 2050, based on scientific evidence provided by the IPCC and the European Environment Agency (EEA).

This strategy has major implications at the national level. A concrete example of Italy’s implementation of science-based climate policies is the Integrated National Energy and Climate Plan (PNIEC), initially adopted by the Ministry of Environment and Energy Security (MASE) in December 2019 and subsequently revised in June 2023 to align with the latest EU regulatory framework.

The PNIEC serves as an instrument for implementing Regulation (EU) 2018/1999 on the governance of the European Union in the fields of climate and energy. It requires EU member states to submit ten-year national plans, starting from the 2021-2030 period, outlining objectives, measures, and national policies to achieve the EU’s long-term energy and climate goals, including a 55% reduction in greenhouse gas emissions by 2030 and climate neutrality by 2050.

However, the effectiveness of these policies ultimately depends on the political system's ability to integrate and implement updates based on the latest scientific discoveries.

In this regard, the PNIEC takes some initial steps forward by providing:

- a periodic review mechanism to allow adaptation to scientific and technological advancements;
- the involvement of ISPRA and CNR in providing updated data on emissions and carbon absorption capacities across different economic sectors;
- the participation of civil society and businesses through public consultation processes, in line with the Aarhus Convention.

Regarding this last aspect, the consultation took place at an intermediate stage before the final adoption of the plan, involving civil society and stakeholders such as businesses, associations, and academics. At the institutional level, consultations included other relevant central administrations, Parliament, regional and local authorities, as well as nine Italian cities selected as part of the EU Mission "100 Climate-Neutral Cities by 2030".

Additionally, interaction is planned with the Interministerial Committee for Ecological Transition (CITE), established by Decree-Law No. 22 of March 1, 2021, and with the Regulatory Authority for Energy, Networks, and Environment (ARERA), which oversees and regulates measures to ensure their consistency with national and EU energy policies.

Nonetheless, this remains an ongoing process, as shown by the ongoing dialogue with the European Commission. Most recently, on March 7, 2024, the Commission issued a Recommendation to Italy on the proposed update of the Italian PNIEC (Recommendation 2024/599), further emphasizing the role of scientific evidence.

Among its recommendations, for instance, the Commission urged Italy to specify the amount of CO₂ emissions that could be captured annually by 2030, along with their sources and capture methods, and to present further analyses of climate risks and vulnerabilities in relation to national targets, milestones, and policy measures across different dimensions of the Energy Union.

These recommendations highlight the necessity of strengthening the science-based approach through mechanisms and procedures that ensure the systematic and effective integration of scientific evidence into public policies. This is essential to guarantee regulatory measures based on up-to-date data, balancing scientific rigor with democratic and social needs.

In this context, it is crucial to adopt tools that enable the continuous updating of climate strategies, ensuring that legislative choices are informed by the best available knowledge and aligned with national and European objectives.

3.2 The European Nature Restoration Regulation and its scientific foundation

Another interesting benchmark for these reflections is provided by the law-making process of one key legal instrument of the European Green Deal: The Regulation on Nature Restoration (EU 2024/1991), often called Nature Restoration Law (NRL).

There are several reasons for focusing on this case. Ecological restoration aims to rebuild ecosystem functionality, particularly by fostering resilience - the capacity of ecosystems to absorb disturbances and recover without losing core functions. In a warming world, enhancing resilience is one of the most effective climate adaptation strategies.

Second, the focus on agriculture provides an opportunity to engage with a particularly complex and contested domain. Agriculture is situated at the intersection of essential human needs—such as food security—and deeply rooted cultural values. It is also a sector historically marked by intense debate, particularly within Science and Technology Studies (STS) and bioethics, as seen in the long-standing controversies surrounding genetically modified organisms (GMOs). As such, agriculture is saturated with epistemic, normative, and political tensions.

Beyond these conceptual considerations, agriculture occupies a central institutional role within the European Union, accounting for roughly one-third of the total EU budget and involving a wide array of stakeholders with conflicting interests. The Nature Restoration Law (NRL) illustrates this vividly: the obligation to restore agricultural ecosystems triggered intense public and political controversy, demonstrating how scientific evidence can operate both as a foundation for policy and as a site of contestation in legal decision-making.

The Nature Restoration Regulation (EU) 2024/1991 is the first instrument adopted by the EU comprehensively addressing the restoration of terrestrial and marine ecosystems in the continent, and from its very outset it has been framed as strongly rooted in scientific and ecological knowledge. Even the choice to propose a Regulation - rather than a Directive - was explicitly justified in the accompanying documents on scientific grounds. Supporting materials, including the impact assessment, underscore the need to rely on the “best available science” to set restoration targets, define ecological baselines, and anticipate the long-term resilience of ecosystems under changing climate conditions. The law is thus presented as science-informed and future-oriented, designed to evolve through adaptive policy mechanisms.

The process through which scientific knowledge was translated into regulatory content was also particularly noteworthy. According to the impact assessment (Annex VI), the drafting of the proposal involved a multi-stage consultation process. Initially, the European Commission collaborated with in-house scientific bodies such as the Joint Research Centre (JRC) and the European Environment Agency (EEA), alongside external contracted experts responsible for providing targeted input on key elements of the proposal. This phase was followed by five thematic workshops, which brought together a wide range of stakeholders - including government representatives, NGOs, industry actors, and policy consultants - offering diverse perspectives, disciplinary backgrounds and interests. The participatory scope was further expanded through two rounds of open public consultation, conducted via the Commission’s online portal and accessible to all EU citizens.

This structured, inclusive, yet stratified process culminated in the 2022 draft proposal. However, the subsequent negotiation phase proved highly contentious, particularly around Article 11, which set obligations for the restoration of agro-ecosystems. Key points of disagreement concerned both the quantitative targets and the binding nature of the provisions - most notably, whether the text should obligate member states to “ensure” or merely “aim to ensure” specific restoration outcomes. The debate reached its peak in Spring 2024 with the high-profile farmers' protests in Brussels, which cast doubt on the feasibility, legitimacy, and political sustainability of the proposal. It is noteworthy to highlight that some of the critiques which emerged in those days were exactly directed at the vagueness and selectivity of its epistemic foundations, thus challenging its legitimacy. These events illustrate how scientific

evidence - while formally central - can also become a battleground of values, interests, and contested knowledge.

Among others, deep questions arise regarding the normative framing of ecological restoration. Studies in restoration ecology and environmental humanities emphasize that restoration is not a purely technical process, but one imbued with social and cultural dimensions: it involves choices about what to restore, to which baseline, and for whom. Yet the NRR only partially acknowledges these aspects, primarily allowing for socio-economic considerations in exceptional cases, and often refers to the need of referring to the “best available science”, without clarifying what that actually means. In absence of benchmarks or shared methodological standards, this issue become particularly relevant at the implementation stage, where member states will be required to justify how and where to intervene, also justifying how national targets align with the “best available science”.

Another weakness of the NRR is its strong reliance on formal scientific knowledge, which may unintentionally marginalize other knowledge systems - including local ecological knowledge, agroecology, and community-based restoration practices - that are crucial for effective and context-sensitive implementation. Without institutional mechanisms to accommodate epistemic pluralism, the governance of restoration risks becoming overly technocratic and disconnected from social realities.

These tensions have broader implications for environmental governance. As noted in critiques of crisis policymaking (Ragone, 2022), embedding scientific advice within legal instruments demands not only technical competence but also a commitment to democratic openness, institutional reflexivity, and participatory legitimacy. The NRR illustrates the potential of science-based regulation to guide transformative policy - but also its fragility when procedural transparency, pluralistic engagement, and epistemic humility are not upheld.

4. The contribution of international case law to the development of evidence-based decision-making in the climate change issue.

In the light of uncertain scientific data and the phenomenon of anthropocentric climate change, whose negative consequences are not easily localized and identifiable, international judicial decisions also offer relevant insights into the implementation of science-based legislative methods and procedures. In this sense, both the reasoning of the courts in the context of litigation against states and those against multinational corporations are interesting. The focus on judicial decisions is also a consequence of a steady increase in litigation. Failure to take action or inadequate action to combat the adverse effects of climate change and the resulting violation of human rights has led to a series of lawsuits aimed at forcing states to adopt decisive solutions to combat climate change (the *Sixth Report* of the *Grantham Institute Research on Climate Change* indicates that 230 lawsuits will be filed against states in 2023).

In this regard, the analysis of cases brought against States before international and domestic courts (e.g. *Urgenda Foundation v. State of the Netherlands*, 13th January 2020, Supreme Court of the Netherlands; *Verein KlimaSeniorinnen and others v. Switzerland*, 9th april 2024, European Court of Human Rights) shows how the production and use of scientific data on which there is an internationally recognised consensus (such as the scientific data produced by the Intergovernmental Panel on Climate Change, IPCC) can provide evidence to substantiate the obligation incumbent on States, especially as regards the objective of limiting the rise in temperature by adopting effective measures to that purpose.

Case law indicates that, in order for scientific data to be considered 'certain' and provide evidence of climate change-related damage and the inadequacy of states' actions to prevent it, the data must originate

from internationally recognised scientific bodies. The scientific data that best demonstrate 'certainty' are those produced by the IPCC (Intergovernmental Panel on Climate Change), an intergovernmental scientific body.

The acquisition of scientific data is also one of the subject of states' procedural obligations. These obligations include providing an appropriate regulatory framework at the national level, and contributing to the fulfilment of procedural obligations relating to acquiring the knowledge necessary for sound decision-making, and sharing relevant information among those affected by the potentially harmful effects of climate change.

In conclusion, although scientific data shows that limiting temperature increases requires substantial reductions in greenhouse gas emissions, which are largely produced by private entities, using this data to determine specific reduction rates for each company is complex for the courts.

The key question is whether the reduction obligation for a company can be based on the general, scientifically established standard for states of reducing emissions by 45% by 2030. This reduction rate is mainly based on IPCC reports. Furthermore, is it possible to establish a sector-specific scientific standard for the oil and gas industry? The case of *Shell v. Milieudefensie et al.* (Court of Appeal in The Hague, 12 November 2024, ECLI:NL:GHDHA:2024:2100) demonstrates that the production of scientific data does not necessarily lead to the same conclusions or reduction rates. Therefore, other issues are also connected, such as the essential role of recognised international or regional scientific agencies in the search for data certainty. However, in the absence of specific emission reduction obligations on the part of companies, the courts cannot overcome the fluctuating and thus uncertain element of emissions causing negative climate impacts.

Conclusions

The analysis conducted in this position paper highlights the increasing need for public policies on climate change to be rooted in scientific evidence, while also demonstrating the complexities inherent in achieving this goal. At both the national and European levels — as shown by the Italian scientific reserve principle, the EU's Better Regulation framework, and the legal instruments discussed — we observe a growing procedural and normative demand for science-based decision-making. However, the integration of scientific knowledge into law and policy is anything but straightforward.

Scientific knowledge is inherently provisional and uncertain, while law seeks stability and predictability. This tension requires the design of procedures that are both rigorous and adaptable, capable of accommodating new discoveries without leading to decision-making paralysis or undermining democratic legitimacy. The risk, as illustrated by recent EU regulatory experiences and climate litigation, is that scientific evidence becomes either a rhetorical tool to legitimize predetermined choices or a battleground of competing values and interests, rather than a genuine foundation for responsible governance.

To move forward, it is crucial to develop transparent, participatory, and reflexive methods for integrating science into policymaking. This means not only codifying procedures to ensure the use of the best available science, but also fostering institutional mechanisms that embrace epistemic pluralism, engage stakeholders meaningfully, and balance scientific rigor with social and democratic imperatives. Only through such an approach can science-based policies effectively contribute to addressing the complex, uncertain, and deeply political challenges posed by climate change, while enhancing the legitimacy and resilience of public institutions.

Cop_Scipo aims to contribute to this dialogue, helping to identify concrete pathways for designing methods, reasons, and procedures for science-based policymaking that are fit for the challenges of our time.

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