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THE RELATIONSHIP BETWEEN GENETIC DAMAGE AND ECOLOGICAL DAMAGE

Harrouchi OumelKheir[1], Dlimi Abd allah[2]

[1]Doctor, University Ahmed Draya Adrar, (Algeria).
[2]Doctor, University Ahmed Draya Adrar, (Algeria).

Oumelkheir01@univ-adrar.dz[1]
Abdallahdlimi@gmail.com[2]

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Abstract

Environmental protection has become a central legal challenge in contemporary societies, particularly in light of scientific and technological developments that have intensified risks to natural ecosystems and genetic integrity. Environmental harm has evolved beyond traditional and immediately perceptible forms to encompass complex, cumulative, latent, and scientifically uncertain damage, most notably ecological damage and genetic damage. These forms of harm raise serious challenges for classical civil liability systems, which are traditionally based on personal, direct, and certain damage, as well as a clearly established causal link.

This study examines the legal nature of ecological and genetic damage and highlights the points of convergence between them, with particular emphasis on their non-personal, indirect, cumulative, and probabilistic characteristics. It critically assesses the ability of traditional civil liability rules to provide effective legal protection against such damage, especially in relation to causation, attribution of responsibility, and compensability. Focusing on Algerian environmental legislation, the analysis reveals that despite the recognition of indirect environmental damage and collective standing, the reliance on general civil liability principles remains insufficient.

The study concludes that the absence of an autonomous liability regime for ecological and genetic damage significantly limits the effectiveness of legal protection. It underscores the need for legislative reform capable of accommodating scientific uncertainty and ensuring effective protection of ecological and genetic interests.

Keywords: Ecological damage; Genetic damage; Environmental civil liability; Precautionary principle; Causation; Algerian environmental law; Comparative environmental law.

Introduction

Environmental protection has become one of the most pressing legal challenges in contemporary societies, particularly in light of scientific and technological developments that have intensified risks to natural ecosystems and genetic integrity. Modern environmental harm no longer manifests solely in traditional and immediate forms; rather, it increasingly appears in complex, cumulative, and latent patterns that transcend temporal and spatial boundaries. Among the most significant manifestations of this evolution are ecological damage and genetic damage, both of which raise profound legal and doctrinal questions within the framework of civil liability.

Despite the growing recognition of environmental risks, the Algerian legislator has not provided an explicit legal definition of ecological damage. Nonetheless, Law No. 03–10 on Environmental Protection within the Framework of Sustainable Development implicitly acknowledges this concept by granting environmental protection associations the right to seek compensation for both direct and indirect damage affecting collective environmental interests. This legislative approach reflects an implicit recognition of environmental harm, yet it remains grounded in traditional civil liability principles that were originally designed to address personal and individual damage.

Genetic damage, for its part, represents a particularly sensitive dimension of environmental harm, as it directly affects living organisms and biodiversity and may result in irreversible consequences for ecological balance. The interaction between genetic damage and ecological damage reveals a relationship of mutual influence, whereby each may serve as both cause and consequence of the other. This interconnection underscores the inadequacy of classical civil liability mechanisms in addressing environmental harm characterized by uncertainty, diffusion, and scientific complexity.

Accordingly, this research seeks to examine the legal nature of ecological and genetic damage, analyze their shared characteristics, and assess the extent to which traditional civil liability rules are capable of providing effective legal protection against such harm.

Problematic

The central research problem addressed in this study concerns the adequacy of traditional civil liability rules in dealing with genetic and ecological damage. Classical liability theory is premised on personal, direct, and certain damage, as well as the existence of a clear causal relationship between a harmful act and the injury suffered. However, ecological and genetic damage often fail to meet these conditions due to their non-personal, indirect, cumulative, and probabilistic nature.

This raises a number of fundamental legal questions, including:

- In what ways do genetic damage and ecological damage intersect, and how does this intersection exacerbate difficulties related to causation and attribution of responsibility?
- Does the recognition of indirect environmental damage under Algerian law provide an effective solution, or does it merely highlight the limitations of traditional liability rules?
- To what extent can comparative legal experiences offer alternative models for addressing genetic and ecological damage?

These questions form the core of the study's inquiry and guide its analytical trajectory.

Methodology

This research adopts a **descriptive–analytical methodology**, combining legal analysis with doctrinal interpretation in order to examine the conceptual and legal dimensions of genetic and ecological damage. The study begins by clarifying the notion of pure ecological damage and identifying its distinguishing characteristics, particularly its diffuse, cumulative, and latent nature.

In addition, the research employs a comparative legal approach, drawing on selected examples from French law and European Union environmental law. This comparative perspective aims to highlight alternative liability regimes that recognize ecological damage as an autonomous form of harm and adapt traditional causation standards to scientific uncertainty.

Primary legal sources, including Algerian environmental legislation and international conventions, are analyzed alongside doctrinal writings and judicial interpretations where relevant. Through this methodological framework, the research seeks to assess the effectiveness of existing legal mechanisms and explore potential avenues for reform.

I. Conceptual Framework of Ecological Damage

The Algerian legislator has not provided an explicit statutory definition of ecological damage. Nevertheless, references to this concept appear across several branches of law, most notably in Law No. 03–10 on Environmental Protection within the Framework of Sustainable Development. Article 37 of this law recognizes the right of environmental protection associations to bring legal actions seeking compensation for both direct and indirect damage affecting collective interests that constitute the living environment of individuals (Abbas, 2021, p. 868).

At the international level, the Lugano Convention (1993) defines ecological damage as *"any loss or damage resulting from the impairment or deterioration of the environment."* Similarly, environmental damage has been described as *"any harmful act resulting from pollution caused by human activity that affects the environment and its various components—such as water and air—insofar as these elements are utilized by humans*." (Dhaman, 2021, p. 85).

A distinction must be drawn between general environmental damage and pure ecological damage. The latter refers to harm inflicted upon the natural environment itself or upon common goods that constitute environmental assets, such as water, air, flora, and fauna. These elements are characterized by their collective nature, as they are not owned by any individual and are not susceptible to private ownership.

II. Specific Characteristics of Pure Ecological Damage

Pure ecological damage is marked by several distinctive features, namely its diffuse, cumulative, latent, and uncertain nature. Such damage transcends territorial boundaries and temporal

limits. In most cases, its effects do not manifest immediately following the harmful act, but rather appear after a significant lapse of time and may extend into the future.

Moreover, pure ecological damage rarely results from a single, isolated act. Instead, it is typically the outcome of the accumulation and interaction of multiple substances and factors over time. This cumulative process renders it scientifically difficult to establish the occurrence of damage with certainty—an issue that becomes even more complex when the damage is prospective or future-oriented (Wanas, 2007, p. 258).

In an attempt to overcome these evidentiary difficulties, legal doctrine has proposed recourse to compensation for loss of chance, albeit under very strict conditions. An example includes the loss of opportunity for agricultural crops to succeed due to pollution affecting agricultural land as a result of contamination of a natural element, such as water pollution. However, even where compensation for loss of chance is accepted, it does not aim to repair the final damage suffered by the natural element itself. Rather, it seeks to compensate for the loss of an opportunity to realize a personal interest arising from changes in the physical characteristics of the natural element.

Accordingly, this mechanism remains inadequate for addressing pure ecological damage, which affects the environment as an autonomous value rather than merely an individual interest.

III. Legal Characteristics of Genetic and Ecological Damage and the Challenges of Civil Liability

The relationship between genetic damage and ecological damage is one of mutual and reciprocal influence, whether direct or indirect. Genetic damage may affect natural environmental elements, while ecological damage may, in turn, contribute to the occurrence of genetic damage. Despite the conceptual distinction between the two, they share several fundamental characteristics that justify their joint analysis within the framework of environmental civil liability.

Both forms of damage are characterized by the widespread scope of their effects, delayed manifestation, continuity of harm, and cumulative and sequential consequences. These shared features pose serious challenges to traditional civil liability regimes, particularly with regard to identifying the responsible party, determining the full extent of the damage, and establishing a clear causal link between the harmful act and the damage suffered.

1. Ecological Damage as Non-Personal Harm

One of the defining characteristics of pure ecological damage is its non-personal nature. Classical civil liability rules require that damage affect a right or a legitimate interest belonging to a specific injured party (Source, 1994, p. 353). This requirement creates a fundamental difficulty in cases of ecological damage, which affects natural elements such as water, air, and living organisms. These elements lack legal personality and are therefore incapable of holding rights or seeking legal protection in their own name.

In the absence of specific legal provisions governing civil liability for environmental damage, the Algerian legislator has granted standing to environmental protection associations to initiate legal proceedings for damage affecting their collective interests (Presidential Decree No. 20-442, 2020; Law No. 03-10, 2003, Art. 36; Law No. 12-06, 2012, Art. 17/3). While this procedural mechanism provides a partial solution, it does not fully address harm to the general interest inherent in ecological damage. Nevertheless, within this framework, the environment may be regarded as an injured entity under civil liability rules, albeit indirectly represented.

Furthermore, while civil liability traditionally aims to protect individual property rights, ecological damage often transcends individual interests and affects collective and diffuse interests. Even when pure ecological damage coincides with a personal interest held by a rights holder, it may simultaneously undermine broader ecological interests. For instance, the loss of genetic diversity resulting from the extinction of individuals belonging to a particular species may affect a private interest but, more fundamentally, disrupt ecological balances that do not fall under private ownership.

2. Ecological Damage as Indirect Harm

Another essential characteristic of ecological damage is its predominantly indirect nature. Direct damage arises immediately from a harmful act, such that the act constitutes a necessary and direct cause of the damage. Indirect damage, by contrast, lacks an immediate causal connection to the act in question(Al-Manasir, 2020, p. 28).

Ecological damage often results from the interaction of multiple, complex factors, including natural phenomena. This multiplicity complicates the establishment of a direct causal relationship between a specific wrongful act and the resulting pure ecological damage (Martin, 1994, p. 118). Consequently, ecological damage does not easily conform to traditional theories of causation—such as the equivalence of conditions or adequate causation—which rely on certainty. Instead, pure ecological damage is generally grounded in probability, due to the plurality and interdependence of contributing causal factors(Wanas, 2007, p. 259).

Although Article 37 of Law No. 03–10 recognizes both direct and indirect environmental damage and grants environmental associations the right to seek compensation for damage affecting collective interests, classical civil liability law remains anchored in the principle that only direct damage is compensable. This discrepancy underscores the structural inadequacy of traditional liability rules when applied to ecological harm (Abbas, 2021, p. 870).

Where genetic damage affects natural elements, it acquires the same characteristics as ecological damage and is therefore subject to the same legal limitations. The absence of a distinct and autonomous liability regime for environmental and genetic damage, coupled with reliance on general civil liability rules, significantly undermines the effectiveness of available legal remedies.

IV. Comparative Analytical

From a comparative law perspective, the challenges posed by genetic and ecological damage are not unique to Algerian law. Many legal systems rooted in classical civil liability doctrines encounter similar difficulties in addressing non-personal, indirect, and probabilistic harm. However, certain comparative experiences—particularly in French law and European Union environmental law—have moved toward recognizing pure ecological damage as an autonomous category of harm, independent of personal injury or property damage.

The adoption of specific liability regimes, the relaxation of causation requirements, and the recognition of environmental interests as legally protected values in their own right reflect a shift toward a more objective and preventive approach to environmental protection. By contrast, the continued reliance in Algerian law on general civil liability principles limits the effectiveness of compensation mechanisms for genetic and ecological damage.

Accordingly, comparative analysis highlights the urgent need for a specialized legal framework capable of accommodating the unique characteristics of genetic and ecological damage. Such a framework should recognize the autonomous nature of ecological harm, adapt causation standards to scientific uncertainty, and strengthen the role of collective actors in environmental litigation. Only through such reforms can civil liability effectively respond to contemporary environmental and genetic risks.

Conclusion

The analysis demonstrates that genetic damage and ecological damage share fundamental characteristics that distinguish them from traditional forms of civil harm. Their non-personal, indirect, cumulative, and probabilistic nature renders classical civil liability rules largely inadequate for ensuring effective legal protection and compensation. While Algerian legislation has taken important steps by recognizing indirect environmental damage and granting standing to environmental associations, these measures remain insufficient in the absence of a coherent and autonomous liability regime for environmental harm.

Comparative legal experiences reveal a growing tendency to recognize pure ecological damage as an independent legal interest deserving of protection in its own right. The development of

specialized liability regimes, the relaxation of causation requirements, and the adoption of preventive approaches reflect an evolution toward a more effective response to environmental and genetic risks.

In light of these findings, the study concludes that there is a pressing need for legislative reform in Algerian law to establish a specialized legal framework capable of addressing the unique nature of genetic and ecological damage. Such reform should acknowledge the autonomy of ecological harm, adapt liability principles to scientific uncertainty, and reinforce collective mechanisms for environmental protection. Only through such an approach can civil liability fulfill its role in safeguarding the environment and genetic heritage for present and future generations.

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