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LEGAL FRAMEWORK FOR AQUACULTURE IN BRAZIL: ASSIGNMENT OF WATERBODIES AND ENVIRONMENTAL IMPACTS[1]

MARCO LEGAL DA AQUICULTURA NO BRASIL: CESSÃO DE ESPAÇOS HÍDRICOS E IMPACTOS AMBIENTAIS

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Abstract
The current aquaculture model is given by assigning the use of waterbodies by public administration to the the private sector so that it exploits natural existing resources. It occurs that this economic exploitation generates consequences for the environment. Thus, the present work questions the legal analysis of the attribution of the ownership of use and the regulation necessary to hinder the extrapolation of limits, which may lead

Resumo
O modelo de aquicultura atual é dado a partir da cessão de uso de espaços hídricos pela Administração Pública para o setor privado, a fim de que este explore recursos naturais ali existentes. Ocorre que essa exploração econômica gera consequências ao meio ambiente. Dessa forma, este trabalho questiona a análise jurídica de atribuição da titularidade de uso e a regulação necessária para que tal cessão não extrapole limites e cause impactos ecológicos negativos, de modo

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to negative ecological impacts, disrupting the natural life in the water course and causing damage to diffuse rights. For this, the dialectical method was used through the observance of Brazilian legal bases that deal with the theme. The methodology used is critical and dialectic. Thus, critical and documental analysis is used to evaluate data and normative criteria related to the practice of aquaculture, according to Brazilian and international data. It was concluded that the assignment of waterbodies should not be understood as a mere territorial assignment, and therefore a regulatory framework for public goods, addressing regulation of impacts, multiple uses and grants based in the national environmental policy (Política Nacional do Meio Ambiente – PNMA) and National Water Resources Policy (Política Nacional de Recursos Hídricos – PNRH) is crucial.
Keywords: aquaculture; water resources; assignment of public goods; regulation mark.

a perturbar a vida natural no curso hídrico e causar danos a direitos difusos. Para tanto, utilizou-se o método dialético, por meio da observância de bases legais brasileiras que tratam no tema. A metodologia empregada é crítica e dialética. Assim, utiliza-se de análise crítica e documental para avaliação de dados e critérios normativos relacionados com a prática da aquicultura, segundo dados brasileiros e internacionais. Concluiu-se que a cessão de espaço hídrico não deve ser entendida como mera cessão de bem territorial, e por isso é indispensável um marco regulatório de bens públicos, abordando regulação de impactos, de usos múltiplos e de outorga fundadas na Política Nacional de Meio Ambiente (PNMA) e na Política Nacional de Recursos Hídricos (PNRH).
Palavras-chave: *aquicultura; recursos hídricos; cessão de bens públicos; marco regulatório.*

Introduction

Effective resource management and the sustainable use of natural resources demand tools for economic planning and the assessment of the consequences of activities that involve the use of environmental assets. The levels of complexity and challenges escalate as specific factors related to the use of natural resources become more prominent and evolve in response to technological advancements. Consequently, there arises a need for technical-scientific evaluations and legal assessments that grapple with emerging realities previously unanticipated.

This article suggests an approach that scrutinizes the aquaculture model, specifically the practice of assigning waterbodies, which involves the Public Administration granting private economic entities the right to utilize water areas for the extraction of natural resources. Technological progress now enables an increased use of waterbodies as arable land.

The assignment of use of public goods or public spaces is commonly assimilated as an assignment of physical area, in either built or open spaces on "firm

ground". Consequently, the assignment of usage has traditionally been framed within legal practices as a form of property, regarded in a physical sense, and becomes a resource that is used by social and economic stakeholders, whether for remunerative purposes or otherwise. The contemporary array of issues primarily revolves around critiquing the practice in consideration of the nature of the public space being provided. Assigning public spaces entails conferring upon an individual an asset of public origin, either due to its ownership characteristics or its categorization as having special or common utility to people with diffuse rights.

The subject gains prominence and distinctiveness when one considers that the area up for assignment is not a standalone property or a clearly demarcated land region but rather an aquatic expanse, which will serve as the foundation for societal and economic stakeholders to harness natural resources qualified as environmental assets. Here, there is an outlining encompassing areas of lakes, rivers, watercourses in general, and marine regions, with enclosure and economic exploitation for aquaculture development. The use of public waterbodies for economic purposes leads to a multitude of ecological consequences.

In this vein, this article mainly aims to question to what extent and degree of regulation on the assignment of river, lake, and even marine areas for exclusive or private use by specific social or economic entities.

The use of waterbodies through assignment results in a series of ecological and societal repercussions, affecting both the scale of production and the generation of waste, which disrupts the ecological balance within water bodies. The advancement of aquaculture practices in these public spaces, subject to assignment, poses a challenge to the legal framework which encompasses an analysis of the mechanisms for conferring the right to use and the establishment of procedures for regulating the impacts produced. Consequently, there is a need to position the development of this activity within the context of environmental permitting and anticipate its impact on existing ecological interactions.

The approach developed is based on the dialectical method, through which it seeks to develop a critical matrix regarding the existing regulatory framework, in addition to aspects of legal instability and ecological risks related to the development of aquaculture activities in public waterbodies. Within this normative context, the dialectical analysis examines the legal foundations established by Law No. 9,636, enacted on May 15, 1998, and primarily focuses on the provisions outlined in Decree No. 10,576, enacted on December 14, 2020, to specifically address the assignment of right to use for physical spaces within bodies of water under the domain of the Union for the purpose of practicing aquaculture.

In the first chapter, a general overview will be made of how public goods are currently managed in Brazil, especially the management of water-based environmental goods. Subsequently, a distinction will be made between water and waterbodies, addressing the use of the latter for aquaculture, as well as the legal regulation given to this form of exploitation. The third chapter will delve into the legal procedures governing the assignment of waterbodies to individuals by the Public Administration. Finally, we will discuss the ecological ramifications arising from such practices and the associated environmental permitting procedures.

1 Waterbodies and the management of public goods

The administration of public goods is typically associated with how the Public Administration oversees real estate, whether it is developed or not. The original basis for understanding usage regulations is rooted in the Civil Code from which it developed and became the object of greater sophistication. Art. 99 of the 2002 Civil Code defines public goods as those used for the common benefit of the public, such as rivers, seas, roads, streets, and squares. It also encompasses assets designated for specific public use, such as properties or lands intended for the use of Public Administration entities. Additionally, it includes dominical assets, which are tied to the holdings of legal entities governed by public law (BRASIL, 2002). This provision does not deviate from the framework previously existing in Art. 66 of the Civil Code of 1916 and operates within a regulatory context where legal parameters exclusively dictate potentialities and usage boundaries.

The circumstances and real-world applications of legal norms have prompted a shift away from solely relying on legal parameters. Instead, they have increasingly incorporated parameterizations rooted in technical and scientific evaluations from diverse fields such as biology, ecology, and engineering, which become the underpinnings through which legal structures shape both the regulatory framework and the specific standardization of each resource category. The complexity associated with public goods and their normative governance varies according to the intended purposes and the range of uses allowed in the regulations, perpetually challenged by technological advancements. The Law is no longer confined to exhaustive regulatory provisions; it serves as an initial framework from which lower normative acts stem, weaving greater depth and regulatory certainty into the management of public goods and spaces.

There is no shortage of examples. Areas adjoining highways, referred to as 'right-of-way', governed by DNIT Resolution No. 9, enacted on August 12, 2020,

public properties assigned for the public interest, overseen by SPU Normative Instruction No. 87, enacted on September 1, 2020, and even public forests, as per Interministerial Ordinance No. 7, enacted on December 30, 2020, serve as examples of objects subject to regulation for third-party use, whether for compensation or otherwise, within the purview of the Public Authority. This is determined by specific provisions tailored to each type of asset, considering their distinctive social and economic functions (BRASIL, 2020c; 2020d). Public goods are now governed by normative usage rules based on the technical and regulatory options they progressively encompass. This aspect of specificity and adaptability has led to an increased application of the principle of relative legal reserve (MENDES; BRANCO, 2015), by which the Law establishes regulatory standards to be adhered to, which are then further defined and implemented through subordinate normative acts.

The economic and technological advancement in the exploitation of natural resources has broadened the traditional perspectives on the use of publicly owned goods. There is a constant interplay between legal standardization and the potential for technological or economic use, all while considering the unique characteristics of the diverse and heterogeneous regions of Brazil. The geographical element is intertwined with cultural, climatic, social, and economic aspects. This dynamic significantly influences the determination of usage and, consequently, its resulting legal framework. In the context of water resources, the situation distinctively presents itself, deviating from the original conceptual unity to embrace a complex diversity.

The situation becomes even more intricate in the case of public goods that also qualify as environmental assets. The regulatory implications of Art. 225 of the Constitution of the Republic, as a cornerstone of understanding, give rise to scenarios of diffused rights that permeate the specific regulatory characteristics of goods affected by environmental quality. The article identifies environmental assets as those that are meant for common use by the people. In this regard, the text conveys not only the concept of public goods but also the notion of goods with a diffuse connection to value and legal regulation (BRASIL, 1988).

As advocated by Geraldes (2004, p. 86), "on one hand, there are those who interpret water resources as public goods, owned by either the federal government or the respective state, as applicable". Conversely, some perceive that Art. 225 has established "a new category of legal assets, breaking away from the traditional public/private good dichotomy, and defining the environment as a diffuse good, available for common use by all" (GERALDES, 2004, p. 86). It is within this

ambivalent scenario that legal norms governing the regulation of waterbodies and water bodies, with their varying dimensions, are situated (LORIDO, 2017). The starting point is to understand that "what the constitution intended to convey is that the environment represents a distinct legal asset, separate from those over which property rights are exercised" (BARROSO, 2011, p. 1016).

The factors linked to the use of goods constituting natural resources, whether from the standpoint of categorizing them as public goods or as common diffuse goods, also raise the issue of private use or use by private entities for their direct gain, albeit with indirect collective benefits. This brings us to the ongoing concern of private use of collective goods, a persistent matter concerning water resources. The use of public or common goods by individuals with exclusive rights demands justification and legal backing to prevent it from manifesting as an indirect privatization of environmental resources. Consequently, whether viewed through the classification of goods as public or through their classification as diffuse, the use by individuals, denoting exclusivity, necessitates alignment with the considerations of the public interest (COSTA; SAMPAIO, 2020).

This justification is not inherently evident and, therefore, is subject to substantiation from legal and political-social discourses. This phenomenon is notably evident within the national regulatory landscape concerning water resources.

In 1934, Decree No. 24,643, enacted on July 10, was edited in Brazil, establishing the Water Code (Código de Águas). According to the standard, waters were categorized as public, available for communal, leisure, or private use (BRASIL, 1934). Even then, the legislation recognized the limited nature of abstract legal frameworks for defining the classification and regulation of water uses, although it primarily focused on those related to human supply and navigation. Art. 36 of the Water Code explicitly stated that as early as 1934, regulatory constraints were prescribed by Law, calling for specific subordinate normative acts for each property type and water use. Such acts defined provisions regarding the use of water resources following regulations. The intricate regulatory diversity emerges from this multifaceted perspective of concurrent potential uses, for which subordinate regulations were deemed the most suitable method to address contemporary demands.

The use of water resources is progressively shaped by assessments of human impact on the environment. The utility for human beings is now juxtaposed with the ecological consequences of interventions on the environmental asset of water. Along these lines, the technical approach adopted by the National Water and Sanitation Agency (BRASIL, 2019) in a study on consumptive water use in Brazil

is noteworthy, spanning from 1931 to the base year of 2017, with projections up to 2030. The technical and managerial analysis defines consumptive use as "when the extracted water is used, either partially or entirely, in the process for which it is intended, without returning directly to the water body" (BRASIL, 2019, p. 1). uses that do not qualify as consumptive are not the primary focus of water management, which is reflective of the perspectives enshrined in the Water Code.

While the Water Code accorded special attention to navigable or floatable waters, analyses by the National Water and Sanitation Agency classify these uses as non-consumptive. This includes leisure, tourism, and fishing activities, as they do not significantly affect the amount of water available. The consumptive nature of water pertains to uses that result in a quantitative demand and qualitative impact on water resources or water bodies themselves. The primary consumptive uses of water encompass human and animal supply, irrigation for agriculture, industrial applications, mining, thermoelectric generation, and the creation of artificial reservoirs (BRASIL, 2019). These uses entail the withdrawal of water from watercourses and involve activities that directly or indirectly affect water quality and/or usage patterns, which includes the intended purpose of the water body itself.

This serves as the focal point for water management and assessment. As highlighted by D'Isep (2017), this focal point is characterized by the fact that "The management of inland waters in Brazilian Law follows a tripartite logic (Public Power, users, communities) within the hydrographic basin as a territorial unit of management, with the water resources plan serving as its guiding and managing instrument" (D´ISEP, 2017, p. 70). At the quantitative level, water is subject to technical and regulatory evaluation by Water Agencies, while, at the qualitative level, particularly concerning raw water, environmental bodies play a predominant role.

This is delineated by normative parameters, as evident in Law No. 9,433, enacted on January 8, 1997, which establishes the National Water Resources Policy (Política Nacional de Recursos Hídricos, PNRH). Art. 9 of the PNRH dictates the classification of water bodies into classes based on their predominant uses. This classification not only ensures higher water quality but also reduces the costs associated with pollution control through continuous preventive measures. Subsequently, Art. 10 specifies that the classification of water bodies is to be established through environmental legislation (BRASIL, 1997a).

The sub-legal regulation of the PNRH for the classification of water bodies was accomplished through CONAMA Resolution No. 357, enacted on March 17, 2005. These water classes consider the prevailing and future uses tied to the

water body, as well as the ecological functions and human requirements associated with them. Impact assessments and analyses can be ecotoxicological, focusing on the detrimental effects of physical or chemical agents on aquatic organisms, or toxicological, evaluating the potential risks to human health. The resolution sets out 13 quality classes, categorized into fresh, saline, and brackish waters. Each class includes specifications for turbidity, allowances for discharges, admissibility for discharges, and various chemical composition levels, serving as criteria for compliance assessments. The legal suitability of an activity depends on its compatibility with the designated watercourse class.

In particular correlation with aquaculture, Resolution No. 357/2005, in Art. 10, allows for the adjustment of maximum permissible values for nitrogen and phosphorus parameters, considering natural conditions or findings from specific studies on the effects of diffuse pollution related to the water body (BRASIL, 2005). A crucial aspect is the flexibility in evaluating the compatibility of discharges and the absence of hardening in assessing the conformity of abstract parameters concerning the current conditions of each community, population, or ecosystem.

The establishment of water classes is vital for assessing water quality and evaluating the feasibility of projects using natural resources or those that may lead to environmental pollution, either actually or potentially. Furthermore, "the establishment of a water classification system is essential to organize the administrative framework designed to monitor the quality control of inland waters" (ANTUNES, 2014, p. 1161).

The management of water environmental resources involves collaboration between different entities, where Water Agencies or water management bodies assess the potential availability, while environmental bodies establish parameters and indicators to monitor the impact of human activities on watercourses and reserves. The contextualization of water use relies on technical classification criteria linked to both quantitative elements and indicators of usability, as well as qualitative factors concerning the presence of substances that are either permissible or restricted to defined levels. Regulatory functions are delegated to sub-legal acts, with the Law setting out broad parameters and regulatory references. In this context, the normative functions carried out by the Public Administration gain significant importance.

At the federal level, the National Water and Sanitation Agency (Agência Nacional de Águas e Saneamento Básico, ANA) is responsible for defining levels of assignment or availability of use. Meanwhile, at the state level, the task falls to

state water authorities, depending on the specific configuration within each state of the federation. The ownership of the watercourse, as stipulated in Art. 14 of the PNRH Law serves as the determining criterion for this assignment.

The ecological impact assessment of activities is conducted by environmental bodies, following the assignment of responsibilities defined in Complementary Law No. 140, enacted on December 8, 2011. Consequently, an activity within a federal watercourse might undergo environmental evaluation and licensing by a state or even municipal authority, just as there could be federal jurisdiction for environmental permitting concerning an activity that impacts a state watercourse. Activities that require the consumptive use of water must undergo simultaneous assessment regarding state authorization for quantitative and qualitative use. The former is granted through water permits, while the latter is regulated through environmental licenses or authorizations.

However, this does not mean that water management bodies and sectoral entities do not share responsibilities in safeguarding water quality. While quantitative and regulatory management is indeed their primary focus, they do not neglect the preservation of water quality. In the case of the latter, environmental agencies play a prominent role in defining the quality, both from a regulatory and supervisory perspective. As pointed out by Machado (2018, p. 60), "ensuring water quality is a joint responsibility of both the public environmental bodies and water management bodies when they operate as separate sectors within the Public Administration". Systemic complexity lies in precisely defining the realms of responsibility and coordination among the various stakeholders engaged in water management, encompassing both quantitative use and ecological quality considerations.

The normative framework, which coordinates the management of water environmental resources based on quantitative and qualitative elements, significantly impacts consumptive water use in agriculture and especially in aquaculture. Water management and administrative impact assessments encompass multiple aspects, including the determination of quantitative levels for the use of public water resources, as well as the assessment of quantitative water demands within diverse usage scenarios and ecological impacts on water quality.

The waterbodies is comprehended not only in terms of its territorial dimension as a public good but also as a resource for environmental management that can be used in productive human activities. These distinctions give rise to regulatory frameworks that incorporate various legal instruments, with the foundational principles set by the Law but with specific regulatory structures and implementations outlined in sub-legal acts.

2 Waterbodies and aquaculture

Water and waterbodies should not be conflated. Water itself is an environmental asset and a natural resource. In contrast, "waterbodies" refers to the territorial delineation encompassing a specific physical portion of a water resource. The management of public goods pertains to the regulation of the asset itself as well as the space where it is situated. The use of not only water but the waterbodies itself for the assignment and demarcation of areas for aquaculture has been gaining prominence in the regulatory framework in Brazil. This is because there is no environmental asset or natural resource whose use does not imply effects on competitive applications and purposes.

The legal regulation of protected spaces facing water resources for productive cultivation is governed by the Forest Code (Código Florestal), Law No. 12,651, enacted on May 25, 2012. It is based on constraints regarding the use of permanent preservation areas (PPA) (BRASIL, 2012). Here, economic uses are primarily understood in the context of constraints on the removal of vegetation from the banks of watercourses. Legal norms assimilate the interdependence of ecosystems to ensure a balance of use and outcomes.

On the other hand, the exploitation of water resources for various activities, such as the generation of electrical energy and the creation of artificial reservoirs for human consumption, is understood from the perspective of the water permit, as regulated in Law No. 9,433/1997 (BRASIL, 1997a). The assignment of water usage permits for productive crops, which dictates the use of natural resources, is traditionally subject to regulation and scrutiny primarily focused on the contrast between irrigation technologies rather than the exploitation of the natural resources within the waterbodies itself. The provision of waterbodies for aquaculture clashes with common understandings of the management of natural resources and the management of public spaces. It questions the granting of waterbodies for private and productive purposes, leading to the establishment of actual water farms located within watercourses.

While common understanding typically places greater emphasis on the regulation of land use and occupation in the management of environmental impact, new technological methods for exploiting water resources raise concerns about the use and occupation of water itself, impacting the entire watercourse and its banks. In practical terms, technological and productive processes enable the potential enclosure and demarcation of sections of rivers, lakes, lagoons, and even the open sea for the cultivation of fish or crops, a practice known as aquaculture. This is

distinct from traditional aquaculture, which relies on human-constructed tanks, as it is now conducted directly within natural environments. Confinement levels are established for cultivation and production. There is no direct legal framework governing this activity; instead, like other practices, its foundation and regulatory framework are primarily established through sub-legal implementation.

The debate concerning the repercussions of these novel technologies and methods for exploiting water bodies has gained heightened significance and intricacy following the issuance of Decree No. 10,576/2020, which allows for the assignment of demarcated and cartographically designated areas to private entities for the aquaculture-based use of watercourses, employing the mechanism of use assignment for this specific purpose. Consequently, the circumscription of waterbodies effectively designates them for private economic use, despite their primary status as public goods (BRASIL, 2020b).

The first aspect to take into account in this context is the constitutional framework governing the control of water resources. Watercourses may fall under the control of either the Union or the states, following the provisions of Art. 20, III of the Constitution:

> […] lakes, rivers, and any watercourses on land under Union jurisdiction, those that demarcate boundaries with other nations, or those that extend from or into foreign territory, as well as land banks and riverbanks, are under the control of the Union (BRASIL, 1988).

Thus, the regulatory authority for the use of said water resources is attributed to the Union.

Nevertheless, the states have the authority to regulate and oversee the use of water resources constitutionally designated as state property. Art. 26, I, specifies that surface or underground waters, flowing, emerging, and deposited, are the property of the states, except in cases stipulated by Law, such as those arising from Union projects (BRASIL, 1988). There will, therefore, be a double normative rule to determine the uses attributed to natural resources arranged as waterbodies, concerning quantitative uses. The federal government will ascertain the use of waterbodies in national watercourses, whereas state governments will manifest the regulatory authority over waterbodies within state watercourses, determining the regulatory management of circumscribed areas according to ownership. Such determination precludes municipalities from defining or overseeing waterbodies in Brazil concerning their assignment for use, although this does not imply their exclusion from regulating environmental aspects of the ramifications of said interventions.

The diversity of ownership establishes the regulatory and dispositional nature of waterbodies. Federal regulations about this subject matter are restricted to assets under federal jurisdiction and do not influence or restrict how states establish their own territorial waterbodies to grant private entities access to the extraction of economic resources within an environmental framework. As a result, Decree No. 10,576/2020 has limited applicability to Union assets in federal watercourses. It should be understood not as an environmental standard but rather as an administrative guideline for the management of public waterbodies.

The second point of approach to understanding this topic relates to the regulatory legal framework. The use of waterbodies in federal watercourses is subject to open regulation and administrative management, as outlined in Art. 18, § 2 of Law No. 9,636/1998, which rules upon the administration of Union property. The Law stipulates that, at the discretion of the Executive Branch, it is possible to assign, either free of charge or under specific conditions, physical areas within public waters. This includes spaces in lakes, rivers, and any watercourses, through the assignment of use, following the provisions of Decree-Law No. 9,760, enacted on September 5, 1946 (BRASIL, 1998). Moreover, Section III, § 6 of Art. 18 provides an exemption from "competitive bidding for the assignment of use related to physical spaces in bodies of water under the Union's dominion for aquaculture purposes, within the scope of aquaculture regularization developed by public administration bodies or entities" (BRASIL, 1998; our translation).

This regulatory framework segregates different thematic or normative aspects, delineating the assignment of use and exploitation of areas within water bodies for exclusive management by the Executive Branch, even waiving competitive bidding for the assignment of physical waterbodies for aquaculture. With the enactment of Law No. 14,011/20, a new scenario has emerged for the use of water resources and Brazilian federal waterbodies for aquaculture purposes. Normative conditions are established for the development of actual flowing water aquaculture systems and actual water farms situated within the domain of federally owned water resources, now formalized within an expansive legal framework. This institutionalization designates waterbodies for economic and social activities associated with the cultivation and production of aquatic species.

It is within this context that Decree No. 10,576/2020 comes into play, succeeding Decree No. 4,895, enacted on November 25, 2003, and subsequently revoked by it. It brought consistent changes. Decree No. 4,895/2003 laid the groundwork for authorizing the use of waterbodies for aquaculture purposes in federal watercourses (BRASIL, 2003). It was preceded by Decree No. 2,869,

enacted on December 9, 1998, and Decree No. 1,695, of November 13, 1995. The trajectory of regulatory enactments has followed a divide between provisions governing ownership and right to use and environmental regulations concerning aquaculture activities. The initial Decree No. 1,695/1995 mandated the registration of aquaculturists with the Brazilian Institute of Environment and Renewable Natural Resources (Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis, IBAMA), which included the submission of a sanitation control plan and the monitoring of water quality within the scope of the operation. The regulatory framework introduced by Decree No. 10,576/2020 is multifaceted. It is within this framework that the coordination between qualitative and quantitative elements in the management of waterbodies, as well as the environmental dimension of water in all its aspects, is embedded.

In this latest decree, which provides the current regulatory framework for aquaculture in waterbodies within the federal public domain, the goal is to boost Brazilian fish production alongside sustainable development. In its Art. 3, the decree delineates three fundamental concepts for the utilization of water resources: the aquaculture area, the aquaculture park, and the assignment of the right to use for the exploitation of water resources within the scope of waterbodies (BRASIL, 2020b).

The aquaculture area is defined as a "continuous and delimited physical space in bodies of water under the Union's dominion, intended for aquaculture projects, whether of economic, social, or scientific interest, either individually or collectively" (BRASIL, 2020b). A set of aquaculture areas can be aggregated to form an aquaculture park. The aquaculture park, therefore, is unrelated to an area designated for environmental protection or limitations. In other words, it does not align with the definition of a park within the regulations for conservation units outlined in Law No. 9,985, dated June 18, 2000.

It is a "defined area within an aquatic environment, which encompasses a collection of interconnected aquaculture zones, and where intermediate physical areas allow for the pursuit of activities that align with aquaculture practices" (BRASIL, 2020b). The concept of an aquaculture park is associated with a vision of productive continuity, resembling water farms designated for aquaculture. To secure the assignment of waterbodies, the right to use water resources is provided for a predetermined duration through an administrative decision issued by the National Water and Sanitation Agency (ANA).

The Decree classifies aquaculture areas into categories such as areas of economic interest, areas of social interest, and areas of research or extension. This

differentiation is based on the specific intended purpose of the water resource. Areas of economic interest are designated for individuals or legal entities engaged in aquaculture and focused on the commercial production of fish. Meanwhile, areas of social interest are designated for use by traditional peoples, communities, and participants in social inclusion programs. There is a split based on the intended purpose, with regulations aimed at facilitating production as opposed to designating areas for activities associated with traditional ways of life. This scenario may give rise to issues concerning the compatibility of uses when both intended purposes are connected to the same water territory, especially when no predetermined criteria have been outlined by the regulatory framework. The research and extension areas are designated for Brazilian institutions to foster scientific, technical, and technological development.

The distinction drawn in the regulatory framework is relevant. Assignments for economic interest inherently involve financial obligations, with costs fixed at the time of the assignment itself, unlike the two other designated uses. Furthermore, the characterization of an aquaculture park, presumably based on its production-oriented purpose, will likely occur more frequently in the case of aquaculture areas of economic interest. Regarding the management of water resources and federal assets, the qualification as an economic interest and an aquaculture park will entail direct consequences foreseen in the Decree. Art. 11 of the Decree states that the management of aquaculture parks can be delegated to states, the Federal District, and municipalities (BRASIL, 2020b). This means that the administration of these areas may no longer be handled by federal agencies, to which only an annual report on activities related to monitoring the use of resources within federal waterbodies would be submitted.

Delegation is feasible under certain conditions "I — the expression of interest; II — the provision of qualified technical personnel; III — the presentation of a technical assistance plan; and IV — the submission of training and an annual activity report" (BRASIL, 2020b; our transaltion). This implies that the management of federal waterbodies and the administration of aquaculture activities conducted in these spaces can, through a decree, be undertaken by states and municipalities, effectively designating them as agents responsible for implementing the uses and administration of federal assets. The agreement does not specify any further details about its objects, or provide specific limitations or care requirements concerning the federal asset.

The crucial point to note is that delegation has the potential to entirely transform the dynamics of asset management, reshaping the regulatory and

developmental role that would typically be carried out by the Union within the regulatory framework, as outlined in the Decree. This issue becomes even more complicated when considering the possibility of delegating water management of federal water bodies to municipalities, as the resulting impacts will affect the entire chain of areas located downstream of the projects within the aquaculture park. The regulatory framework for the assignment of waterbodies should not disregard the fundamental starting point of water resource management, which comprises an evaluation of availability, encompassing quantitative repercussions, considering the diverse uses of water, as well as qualitative assessments in compliance with regulatory requirements linked to the different classes of water resources. In cases of delegation to municipalities, the act of delegation must safeguard against any potential adverse effects that could compromise the availability of resources for downstream municipalities.

3 Multiple uses and water regulatory landscape in the assignment procedure

The concept of multiple water use is legally established to govern the utilization of the environmental resource, whether in its economic context or in terms of its utilitarian value. The core concept underpinning multiple uses revolves around enabling the coexistence of various water applications on the broadest and most efficient scale possible to mitigate conflicts over availability and exclusive claims, whether stemming from economic activities or defined groups. Aquaculture operates within this competitive realm of water usage, where unilateral and hermetically sealed applications are not part of its feasibility analysis.

The destinations of water resources have an impact on competitive uses, whether for the waterbodies in question or for water as a natural resource. In any of these diverse scenarios, it is imperative not to lose sight of a significant hermeneutic and all-encompassing tenet—the fundamental right to access water. As per Pes (2019, p. 289)

> […] the right to access drinking water can be recognized as a fundamental right derived from the content of other fundamental rights, notably the fundamental right to the environment, the right to life, the right to housing, the right to food, and the right to health.

Hence, the coordination and optimization of multiple uses must, without exception, align with the principle of both quantitative and qualitative protection of water and its access. Deviation from this principle jeopardizes the present and

future use of this natural resource, and consequently, the accessibility to water itself.

The Dublin Declaration of 1992, arising from the outcomes of the International Conference on Water and the Environment held as a preparatory event for Rio-92, effectively served as a Universal Declaration of Water Rights. The concept of multiple water uses is explicitly addressed in Principle 4 of the Declaration, recognizing the legitimacy of competitive water applications. The Conference report posited that "Combined water savings in agriculture, industry, and domestic supply could significantly postpone investment in the expensive development of new water resources and have a substantial impact on the sustainability of future supplies" (UN, 1992). In simpler terms, effective and productive management allows for flexibility in accommodating various uses, addressing the contextualized needs within society and the market. Both the economic and ecological values of water are on an equal footing.

Principle 4 of the Declaration acknowledges the economic value of water in the context of competitive uses that are equally valid. Managing water in the face of competitive demands for multiple uses serves as a means to combat wastage and as a mechanism for conserving and safeguarding environmental assets. In this sense, Principle 4 states that "water management as an economic good is an important means to achieve effective and fair use, and to encourage the conservation and protection of water resources" (UN, 1992). The international legal recognition of the economic value and multiple uses of water has had a direct impact on Brazilian legislation. Law No. 9,433/1997, providing for the PNRH, outlined the international guideline and established, in its art. 1st, II, and IV, water as an asset of limited economic value, calling for the management of multiple uses of this natural resource (BRASIL, 1997a). Furthermore, Art. 13 specifies that the water permit is contingent upon priorities set in the Water Resources Plans to preserve the multiple uses of water (BRASIL, 1997a). Hence, the consideration of multiple water uses serves as a standard to gauge the efficiency of management systems and the assignment of water permits.

It is crucial to recognize that even water use for aquaculture is part of this competitive arena of multiple uses, and it is intertwined with the consumptive possibilities of this limited and economically valuable resource. The context of cultivating aquatic species in a public watercourse might initially suggest a sense of naturalness and minimal impact, but these notions require in-depth analysis and substantiation. The regulatory framework for the economic assignment of waterbodies areas is entangled in this landscape of competitive disputes over water

uses, as well as the ramifications for various activities, given that it involves a procedure for the permit.

The assignment of waterbodies is more than just the assignment for the use of an asset under federal control; it entails the assignment of an environmental asset with economic value and finite characteristics, within the competitive framework of multiple applications. The assignment of area usage within the assignment of waterbodies has implications for competitive conflicts related to the natural resource itself. It affects catchment areas for human consumption, irrigation practices, and various species' consumptive water usage, with an impact on assessing contamination risks. Moreover, it plays a role in determining the quantities allowed under permits.

The management of water resources, in terms of the impacts of assignments, is closely linked to situations where prioritization becomes crucial, especially in times of scarcity. The assignment of waterbodies for aquaculture will involve the challenging task of identifying priority usage. As the cultivation of specimens will take place within the watercourse, restrictions or priorities for water use cannot be properly measured. Resolution No. 86, enacted on July 5, 2021, from the National Water and Basic Sanitation Agency, outlines one of its specific management responsibilities as declaring a critical condition of water resource scarcity, both in terms of quantity and quality, to determine the effects on fulfilling the diverse purposes of water use (BRASIL, 2021).

The operational assumption is that there may be assignments and restrictions on the permit to ensure compatibility among competitive uses. However, due to aquaculture's unique reliance on water bodies, the management of such permits is inherently limited and offers little room for operational adjustments. Hence, unlike permits for industrial or irrigation purposes, the permit for waterbodies assignment takes on an almost fixed nature, given that the aquaculture project takes place directly within the watercourse.

The purpose of the permit is "to ensure quantitative and qualitative control of water uses, and the effective exercise of water access rights" (BRASIL, 1997a). As outlined in the PNRH Law, in its Art. 12, the permit is applicable for purposes such as capture or diversion, extraction, waste disposal, hydroelectric use, and other activities that impact the water body's regime, volume, or quality (BRASIL, 1997a). The specific and specific dimension of the management of multiple uses concerning the assignment of waterbodies also occurs through the regulatory formalization of the permit, as provided for in Decree No. 10,576/2020 (BRASIL, 2020b).

Art. 3, IV, of the decree defines the permit as an "administrative act through which the National Water and Basic Sanitation Agency – ANA grants the permittee the right to use water resources in water bodies under federal jurisdiction, for a specified duration, following the terms and conditions outlined in the respective act" (BRASIL, 2020b; our translation). However, in the case of waterbodies assignment, the relationship between the permitting authority and the permittee does not involve ANA and the economic or social entities that will utilize the waterbodies. Decree No. 10,576/2020 specifies that the permit must be directly requested from the Ministry of Agriculture, Livestock, and Food Supply. The recipient of the permit will therefore be the Union itself, which will proceduralize the use by social and economic actors (BRASIL, 2020b).

This approach is primarily oriented toward economic exploitation, as the technical evaluation of the project and its water usage is not conducted exclusively by the National Water and Sanitation Agency. An individual or legal entity interested in establishing aquaculture practices submits their technical project directly to the Ministry of Agriculture, Livestock, and Food Supply. The project includes essential elements such as geographic coordinates, a rationale for the chosen location, a description of the production system, and the identification of the qualified individual in charge. The Agency's direct involvement in managing individual projects is eliminated.

The permit will pertain to the right to use Union-owned lakes and reservoirs and will encompass the reservoir's carrying capacity calculated by the Water Agency. This calculation takes into account the deductions for coexisting permits, reflecting the necessity to accommodate multiple uses. In cases involving river courses, the areas designated for aquaculture within a specific stretch are determined to establish usage prerogatives. The responsibility for assessing the project's feasibility lies with the Secretariat, rather than with ANA or an environmental agency. This separation distinguishes the economic-productive evaluation from the environmental impact assessment.

The permit is valid for 35 years. There is a direct complicating element in this setup because, over time, both quantitative and qualitative aspects will be influenced by usage and environmental factors. This includes the potential for cumulative and synergistic effects, with no provision for the direct involvement of the Regulatory Agency in the regulation of water by environmental agencies. The shift of quantitative and qualitative management responsibilities away from the bodies outlined in the PNRH gives rise to apprehensions concerning the sustainability, usability, and quantitative aspects of the natural resource, as well as the ecological impacts stemming from human interventions in waterbodies.

Article 9, §4, of Decree No. 10,576/2020 designates the Ministry of Agriculture, Livestock and Food Supply with the duty of assessing the congruence between aquaculture production and the mean phosphorus load generated by cultivation (BRASIL, 2020b). Thus, in the Decree, the chemical impact of phosphorus interference in cultivation areas is omitted from licensing or environmental suitability evaluations by the entities within the National Environmental System (Sistema Nacional do Meio Ambiente, SISNAMA). Instead, it is entrusted to the management body responsible for production (BRASIL, 2020b). The management of waterbodies essentially becomes a straightforward assignment of space without any comprehensive assessment of quantitative and qualitative interferences from the activity, whether in the short, medium, or long term.

The regulatory framework explicitly delegates the evaluative management role to the Secretariat, while also mandating the Secretariat to share the report on the aquaculture production installed (in tons per year) and the average phosphorus load generated by aquaculture systems (in kilograms per day) in water bodies with the ANA. In the most favorable scenario, the system will rely on data about effects and impacts already incurred during a recent period, without placing a significant emphasis on containing or proactively planning for environmental harm, especially cumulative and synergistic effects.

The assignment procedure transfers the responsibility for both the management of waterbodies and the comprehensive evaluation and measurement of ecological impacts to confined frameworks of assessing patrimonial and economic use, interconnected with production. The challenge of hermeneutical compatibility centers on the degree to which there is an actual departure from the environmental assessments conducted by the entities within the SISNAMA. The assignment of waterbodies is intrinsically linked to the quantitative and qualitative control of water resources, overseen by legally designated public management entities following the coordination established based on the principles of the PNRH. Decree No. 10,576/2020 appears to shift away from this management paradigm, converting the management of waterbodies and water resources into a form of distributive management of economic zones for the exploitation of natural resources, without the support of explicit or robust sustainability frameworks (BRASIL, 2020b).

4 Impacts of water on agriculture

As governments across the globe craft their environmental policies, it is important to recognize that climate change is concurrently reshaping the ecosystems

of our planet. One of the most conspicuous consequences of this transformation is the rising temperatures affecting our water resources.

The ramifications of climate change have wide-ranging effects on the availability of potable water, energy production, agriculture, wildlife, and even the broader climate, which impacts every individual. In this array of changes, water stands as a crucial gauge for comprehending the evolving climate of our Earth and the potential repercussions it may have on all ecosystems in the not-so-distant future.

Over time, there has been a significant improvement in the availability and quality of data for climate change research. In addition to technological advancements, scientific inquiry is delving deeper into the intricate connection between climate change and its effects on water. We now possess a much clearer understanding of the potential scenarios that the future climate might unveil and their implications for water resources.

In 2020, the world confronted a severe pandemic, while unwittingly facing another ongoing global challenge known as anthropogenic climate change, a phenomenon directly or indirectly driven by human activities. Given this complex backdrop, there is an opportunity to invest in alternative sources of energy and, concurrently, explore innovative methods to utilize the increasingly scarce resources Earth can provide.

5 Identification of sectors with a critical impact on global water resources

CDP, an environmental disclosure platform, has introduced the first tool for assessing the pressure that corporations exert on water resources, revealing that the textile, finance, and fossil fuels sectors have the most significant impact on global water security.

This groundbreaking tool is the first of its kind, enabling financial institutions to gauge the relative impact of various industrial activities on global water resources. It effectively bridges a critical gap in data and information, aiding financial institutions in comprehending and mitigating their exposure to water-related risks.

Through the introduction of this tool, CDP aims to empower capital markets with the necessary information to take action on water security—a domain that has often lagged behind other environmental concerns such as climate change in terms of how risks are perceived and incorporated into investment decisions (¿QUÉ SECTORES…, 2021).

6 Devastating effects on water resources and solutions to the climate challenge

According to data from UNESCO, water consumption has increased sixfold in the past century and continues to grow at a rate of 1% per year. Furthermore, climate change, characterized by more frequent and intense extreme events like storms, floods, droughts, and heat waves, is predicted to exacerbate the challenges faced by countries currently experiencing 'water stress', as well as introduce similar issues to regions previously less affected.

Moreover, the report underscores the notion that inadequate water management worsens the consequences of climate change, impacting not only water resources but society as a whole. "Much of the impact of climate change on water resources will take place in the tropics, where most developing countries are located, with potentially devastating consequences for small island states, some of which could be completely submerged" (UN, 2020).

In response to these threats, the report highlights two interrelated strategies for managing and mitigating the risks posed by climate change: adaptation and mitigation. According to the report, adaptation involves:

> […] a combination of natural, engineering, technological, as well as social and institutional measures aimed at curbing damage and leveraging beneficial opportunities arising from climate change. Adaptation options are present across all water-related sectors and should be explored and implemented wherever possible (UN, 2020).

Additionally, the study points out that mitigation entails "human interventions aimed at limiting the sources or increasing the sinks of greenhouse gases" (UN, 2020). While there are mitigation options available across various water-related sectors, many of them remain insufficiently known and implemented.

7 Environmental permitting in the assignment of waterbodies

Impact assessments of aquaculture activities in waterbodies assignment areas can be considered from the perspective of the distribution of effects derived from the project or activity. This scenario might give the impression that there would be no impact on water quantity or quality, as the water body would serve as a site for species cultivation. This could be justified by the notion of minimal water extraction, implying limited consumptive consequences. Nonetheless, this outlook does not observe the ecological consequences of human activity, not only in the immediate environment where the activity is carried out, taking into account the

waste discharged and also the impacts resulting from the introduction of the cultivated species into the waterbodies, while the maintenance of said species, in turn, entails the release of products and feed that are not typically part of the regular composition of the watercourse.

One crucial factor to consider is the introduction of species into waterbodies. The environmental impact should not only be assessed in terms of direct and indirect effects or implications of aquaculture activities. It must also be evaluated on the scale of the species being introduced into the environment, which should include the risk that they may escape from the cultivation area, spreading to other local and regional water environments.

The concern about the impact on aquaculture areas is not only with the impact of creation and production itself but also with the risk of insertion of species that could become invasive or compete with existing native species. Furthermore, factors such as the introduction of food, the proliferation of diseases, interference in life cycles, and even genetic impacts on species should be closely controlled and monitored (MILARÉ, 2018). These variables and interference assessments are related to the Convention on Biological Diversity. Managing both species and environments requires attention to variables that could disrupt the ecological balance.

Aquaculture farming carries the risk of interfering with the food supply in the water and altering the behavior of local or endemic species. Variables like food residues, biodecomposition, and the biophysical characteristics of introduced species can all influence different levels of the trophic chain within the waterbodies. Consequently, situations involving the risk of environmental vulnerability and potential exposure to invasive species must be considered. In this regard, proactive screening and management are essential when it comes to determining the suitability of species that may be subjected to aquaculture practices.

The general rule provided for in Decree No. 10,576/2020 is the permission to use native species. Allochthonous and exotic species, on the other hand, require authorization from IBAMA (BRASIL, 2020b). Autochthonous species are native to a particular region or territory, while allochthonous species originate from outside the area where they will be bred. The potential impact of these introductions can be either predicted through studies or evaluated using ecological models that consider the interactions between species.

IBAMA is primarily responsible for standardizing the species that will be subject to broad or restricted use in aquaculture practice. However, this does not preclude the involvement of state or municipal authorities. The specific circumstances of the area may lead to restrictions or control boundaries established by

state or municipal regulations, issued following the environmental jurisdiction of SISNAMA. Hence, there is the potential for states or municipalities to reasonably limit certain species or aquaculture practices in environmentally sensitive or acknowledged vulnerable areas.

The assessment of compliance becomes more intricate regarding environmental permitting. In Brazil, environmental permitting is defined under Complementary Law No. 140/2011. This regulation characterizes environmental permitting as an "administrative procedure designed to authorize activities or ventures that involve the use of environmental resources, whether they currently or potentially cause pollution or are capable, in any manner, of causing environmental degradation" (BRASIL, 2011; our translation). This is consistent with Avzaradel (2015, p. 616), "Environmental permitting can be described as a mechanism for pre-emptive oversight of activities, grounded in laws, regulations, and technical criteria, to ensure that the venture aligns with the preservation of a harmonious environment".

The implementation of the Law is overseen through CONAMA Resolution. CONAMA Resolution No. 237, enacted on December 19, 1997, identifies projects where there is a presumption of actual or potential environmental degradation, warranting the requirement for environmental permitting across various categories and degrees of demand (BRASIL, 1997b).

The systemic rationale behind the application of the Resolution involves establishing a comprehensive catalog of activities that necessitate environmental permits for their execution, thereby presuming the requirement for state authorization. The authority responsible for conducting the licensing process will be determined by Complementary Law No. 140, and this may include the Union, represented by IBAMA, as well as the individual states, the Federal District, and municipalities, each acting through their respective environmental agencies. Decree No. 10,576/2020 does not contain explicit or suggestive provisions regarding environmental licensing. Instead, there is an indication that the involvement of environmental agencies might not be required, as evidenced by the mandate for the Department of Agriculture to analyze phosphorus levels, an interpretation that directly contradicts the responsibilities of SISNAMA bodies.

Art. 4, Section 1 of the decree specifies that the "Secretariat of Aquaculture and Fisheries of the Ministry of Agriculture, Livestock and Supply shall conduct an initial evaluation of the technical project to assess the feasibility of the aquaculture entrepreneur's request" (BRASIL, 2020b; our translation). The only viable interpretation allowing for the systemic acceptability of this regulation is to regard

it as a sectoral directive outlining the responsibilities of the Secretariat, rather than implying the exclusion of environmental feasibility assessments, which are specific and exclusive to SISNAMA bodies. In other words, the Aquaculture Decree must be interpreted and applied in harmony with Law No. 6,938, enacted on August 31, 1981. Assessments related to the assignment of waterbodies do not negate or replace those regarding environmental impacts. The obligations concerning quantitative assessments and usage in permitting permits do not preclude assessments focused on the environmental quality of water resources.

Activities related to the allocation of waterbodies may trigger the need for licensing, either due to the construction of the infrastructure required for aquaculture development or the impacts of aquaculture on waterbodies themselves. CONAMA Resolution No. 237/1997 does not recognize infrastructure projects as inherently warranting environmental permits unless they involve the construction of dams and dikes, the establishment of drainage channels, the alteration of watercourse paths, or the opening of new channels (BRASIL, 1997b). In terms of endeavors, agricultural activities are envisaged for licensing purposes, encompassing agricultural projects, animal husbandry, and settlement and colonization projects. The utilization of natural resources, the management of exotic wildlife, the management of living aquatic resources, and the introduction of exotic species are recognized as activities that may demand environmental permits (BRASIL, 1997b). There is, therefore, a normative indication of the potential impact of the activity on the ecosystem and the communities residing in the aquaculture project areas.

The reference framework relating to both the infrastructure and the activity itself is fully subject to environmental permitting, as aquaculture activities in waterbodies can result, at least potentially, in polluting impacts. The extent and levels of requirements for permitting may vary, including the possibility of exemption, if, in any specific case, the activity is deemed to result in minimal or insignificant impact. Nevertheless, the dimensions of cumulative and synergistic effects arising from planned projects in aquaculture areas and aquaculture parks inevitably call for an in-depth analysis of imposing environmental control on aquaculture practices. One key aspect to consider is the increase of nutrients in waterbodies.

While common knowledge might perceive an increase in nutrients as a positive development, in technical and scientific terms, this is a situation where an imbalance can result in disruptions to trophic chains, leading to losses and harm to biotic communities and the cycling of substances within ecosystems. Excess nutrients can even impact the living habits of species in the region, which may

be lured into aquaculture areas. Furthermore, the situation can result in increased levels of nutrients that could lead to eutrophication. Eutrophication is defined as "the process of nutrient enrichment, typically involving phosphates and nitrates, in aquatic ecosystems, leading to an increase in primary productivity" (ODUM; BARRETT, 2017, p. 522).

Excessive nutrient enrichment is not conducive to ecological balance; rather, it is detrimental, as it "creates an opportunity for opportunistic 'weed' species that thrive in conditions with high nutrient levels" (ODUM; BARRETT, 2017, p. 149). Eutrophication can lead to a surge in cyanobacteria, disrupt the production of harmful algal toxins, and have repercussions on water oxygen levels, turbidity, and the equilibrium between different species. The consequences, both within the project's immediate impact area and downstream, may include gene flow destabilization and the mortality of fish inhabiting the watercourse. In line with this, Eler and Millani (2007, p. 36) emphasize that water resource eutrophication and the increase in phosphorus levels, resulting in the "blossoming of potentially toxic algae" and elevated suspended materials, are correlated with fish fatalities.

Therefore, evaluating the impacts of phosphorus and nitrogen originating from aquaculture should not be seen as the sole responsibility of water resource management bodies but, primarily, as a matter of environmental control and management. The rise in phosphorus and nitrogen levels disrupts the system, calling for preventive and control measures to safeguard ecological processes and environmental quality. The increase in nitrogen and phosphorus levels can be attributed to several contributing factors but primarily stems from "unabsorbed fish excreta and feed" (TAKAHASHI; SILVEIRA; VASCONCELOS JÚNIOR, 2020, p. 2487).

The problem is exacerbated when practices and behaviors result in overfeeding, either in an attempt to accelerate production or due to inadequate technical oversight, leading to the substantial accumulation of organic waste (SOUZA *et al.*, 2006). This issue is

> […] compounded by the fact that these nutrients act as fertilizers, stimulating the growth of phytoplankton. The heightened organic production within the system results in increased oxygen consumption, particularly at night, which can result in fish mortality (ELER; MILLANI, 2007, p. 36-37).

Ecological control aims to ensure that aquaculture, rather than becoming a source of growth and socio-economic value, does not turn into a cause of losses and conflicts due to the multiple uses of water and the demands placed on water resources, whether directly or indirectly. These factors must be taken into account

even during periods of reduced water flow or water scarcity. After all, a decrease in water volume can lead to a proportionate increase in nutrient release, potentially shifting situations of balance into progressive imbalance.

The impacts of aquaculture can have far-reaching consequences on a cumulative and synergistic scale. In other words, the levels of impact from cultivation, waste, and nutrient release can accumulate over time, interacting with local substances and giving rise to a broader impact. This interaction can also lead to the creation of new substances or synthesized effects. This evolution requires planning and diagnosis to prevent adverse repercussions on other water uses, such as human water supply and irrigation. It can also have implications for the broader production chain, potentially affecting both small-scale and commercial fishing conducted downstream of the project area, especially in the case of aquaculture parks. Hence, environmental planning and analyses are not geared towards constraining or limiting the activity, but rather aimed at enabling its sustainable and balanced development in harmony with environmental assets and other productive activities.

In addition to mitigating the impacts themselves, it is crucial to monitor biological risks and the spread of diseases among aquatic populations. Species introduced for cultivation may carry or develop diseases and parasites. While issues within the breeding site can often be addressed with treatments and veterinary measures, the potential contamination of species outside the breeding site is a cause for concern. Indeed, diseases and contamination can spread to native species in water bodies, resulting in fish fatalities or the suspension of fishing activities, which could significantly impact small-scale fishing and the local ecological equilibrium due to potential ecotoxicological impacts. However, it is crucial to acknowledge that the application of anesthetics, disinfectants, and biocides, even when suitable for the cultivation area, can have lethal or sublethal effects on other species that coexist within or come into contact with the aquatic environments, experiencing their side effects (ELER; MILLANI, 2007).

The risk management of contamination should not be dissociated from the risks associated with viral, bacterial, or any other pathogenic developments. In this context, the establishment of control and management measures for aquaculture activities should incorporate ecological assessments conducted by environmental agencies, either directly or indirectly, through technical prerequisites or monitoring reports as stipulated in surveillance and epidemiological risk management programs for aquatic organisms. Control measures are "aimed at reducing the risk of disease transmission and the spread of diseases through the transfer and movement of aquatic animals" (BUENO *et al.*, 2014, p. 489).

The broadening of cautionary factors and risk management, as aquaculture practices are scrutinized more closely, underscores the essential role of environmental agencies in the evaluation process, rather than just relying on water management bodies or sector-specific entities associated with the productive activity. The perspective advocated by Gomes (2008) regarding environmental permits is pertinent here. Environmental permitting is not merely a superficial act of government oversight; it serves as "a proactive expression of the prevention principle, embodying the principle of source correction" (GOMES, 2008, p. 304).

Its primary purpose is to prevent, minimize, or control ecological risks stemming from human-made projects. The authorization process, using command--control techniques, involves setting emission standards and risk management protocols. This ensures that a project does not shift from being beneficial to turning detrimental to economic and social development. If necessary, it also implements restrictive measures or sanctions to uphold regulatory compliance for water-impact projects (DELL'ORTO; RODRIGUES, 2012). Assessments of the life cycles impacted, depending on the size and pollution potential of the project, serve as criteria for evaluating adequacy and compatibility with production.

Moreover, the Brazilian regulatory framework empowers states and municipalities to establish their own requirements for environmental permitting or specific regulations within their respective territories. This implies that distinct criteria will govern the occurrence and progression of aquaculture activities, dictating whether an environmental permit or even a regulated environmental authorization, is necessary. The diversity of regulatory requirements will oblige entrepreneurs to identify regional and local regulations in addition to federal standards for the development of the activity.

The mere fact that aquaculture activities occur in a federal water body does not automatically entail federal environmental permitting. The ownership of the property does not imply the granting of environmental licensing. Likewise, these activities are subject to restrictions when their impacts have the potential, whether directly or indirectly, to reach conservation units. In such cases, they must demonstrate their compatibility with the designated environmentally protected area category.

The regulatory permission system, based on federal, state, and municipal competencies within the National Environmental System, involves a concrete technical combination that can circumvent abstract analyses that do not align with the environmental aspects of the project. In other words, evaluations of the impact of phosphorus or nitrogen emissions that may be permitted in one affected

area will be detrimental and prohibited in others. This is due to the presence of synergistic and cumulative effects, as well as the relative and potential ecological sensitivity of one region compared to another, including differences in carrying capacity.

The criteria defined in regulations serve as guidelines but require careful examination to ensure their safety and suitability for the particular case under review. In this context, Granziera (2006, p. 200) argues that "environmental regulations are not always objective and precise. In many cases, it falls on the public authority to determine, in specific instances, certain licensing requirements". Hence, "the mere compliance with the standards outlined in the regulation is insufficient. Instead, a more comprehensive, technically oriented assessment of the environmental safety of the venture is required" (GRANZIERA, 2006, p. 200).

These hermeneutical principles and compatibility guidelines are necessary when examining and comprehending the functions of water regulatory entities and environmental agencies. Permits issued by the National Water and Sanitation Agency specify the maximum allowable phosphorus load[2]. However, this authorization does not absolve environmental agencies from imposing restrictions. It is conceivable to bolster the obligations of the SISNAMA bodies by implementing controls and restrictions, either on a permanent or temporary basis, with thresholds lower than those specified by the water regulatory agency. Effective waste management may also necessitate the implementation of impact reduction measures, such as the adoption of biological processes in treating organic materials generated by the aquaculture process (SOUZA, 2009).

The impacts of the activity within areas designated as special ecological protection are crucial factors for both authorizing the project and managing its ongoing development. Law No. 9,985/2000, which establishes the National System of Conservation Units, does not impose an outright prohibition on aquaculture activities, especially within sustainable use conservation units. Aquaculture can be conducted within conservation units, whether in the context of sustainable use or integral protection (BRASIL, 2000).

At this point, it is crucial to emphasize that aquaculture can be located within an aquaculture area designated for scientific investigation, which aligns with categories of more limited use, such as the Ecological Station, which allows for scientific research when authorized by the entity responsible for the unit. Additionally, sustainable use by traditional peoples and communities is allowed in

2 For instance, refer to permit No. 428, enacted on March 17, 2021, which authorized a maximum load of 874.53 kg/day based on the reservoir's carrying capacity.

specific categories of conservation units. To do so, they must adhere to the legal framework for aquaculture in alignment with the regulatory framework corresponding to the conservation unit category. In some instances, an aquaculture area of social interest can be established, which may evolve into an Extractive Reserve or a Sustainable Development Reserve.

The responsibility for environmental permitting falls to the Union, specifically through IBAMA, when the aquaculture project is situated or developed "in Brazil and a neighboring country; in the territorial sea, on the continental shelf; in the exclusive economic zone; on indigenous lands, or in federal conservation units" (BRASIL, 1997b). This applies to Environmental Protection Areas as well, except in cases involving two or more states of the federation. Licensing authority may be granted to the municipalities in cases where the project has limited impacts, taking into account its size, pollution potential, and if it is located within municipal conservation units (excluding Environmental Protection Areas). In other cases, environmental permitting becomes the responsibility of the states. It is important to note that in all these scenarios, the regulatory framework for aquaculture remains sectoral, focusing on usage regulation and permits. However, this does not prevent or bind environmental agencies from assessing the environmental viability of the project.

A specific standard is integrated into the regulatory framework here but is binding on all licensing entities. This is governed by CONAMA Resolution No. 413, enacted on Friday, June 26, 2009, which establishes regulations for aquaculture concerning environmental impact, in conjunction with specific water body regulations that impact permitting and the allocation of the natural resource's quantity of uses. It also covers the regulation of space use, which falls under a sectoral framework (BRASIL, 2009). In this context, the entity responsible for the project is required to submit the environmental license for the project, which acknowledges the polluting impact, to the sectoral agency, or ANA at the federal level. This standard operates with territorial delineation based on the Reference Geographic Unit (Unidade Geográfica Referencial, UGR). The UGR is a defined area within a hydrographic region, with technical and management specifications established administratively. The spatial assessment criterion holds substantial importance, as it forms the basis for species classification concerning their environment.

Species are categorized as allochthonous or exotic if they do not naturally occur in the UGR, while they are classified as native or autochthonous if they naturally originate and exist within the UGR. This means that an aquaculture

project may manage species native to Brazil but considered exotic in a specific UGR simply because they are not natural to that particular region. The vast expanse of Brazil's territory underscores the significance of this criterion, preventing unjustifiable generalizations and biological equivalences that do not account for the context of risk and the impact of aquaculture activities.

Species assessment involves evaluating their potential for harm, encompassing an analysis of the ecological characteristics of the species and its compatibility with the chosen cultivation system. Licensing must also take into account the size of the aquaculture project, considering the actual area or volume occupied. This leads to the establishment of project classes, which correspond to water classes. The potential environmental impact arises from the interplay between the project's size and the potential harm of the species.

Variations in impact are also closely tied to the cultivation system employed. The cultivation system chosen directly affects the levels of food and waste in the water. In the extensive cultivation system, production depends mainly on available natural food, with supplementation of artificial food, but maintaining a medium or low density of specimens. The effects of the extensive aquaculture system contrast significantly with those of the intensive system, as in the latter, there is a complete reliance on the provision of artificial feed, alongside a high population density of specimens. In a semi-intensive system, despite the primary reliance on artificial foods, available natural foods are also used, and the specimen density is kept at a low or medium level.

The production system, the scale of the project, and the species' level of intensity underscore the necessity for environmental assessment criteria, which should not be conflated with sector-specific analyses. This combination of factors results in various types of environmental permitting, including simplified licensing and even licensing exemptions. CONAMA Resolution n. 413/2009 specifies that small aquaculture projects, regardless of their potential for harm, as well as medium-sized projects with low potential for harm, may qualify for simplified licensing. Nonetheless, for this to transpire, projects should not be sited in areas with high aquaculture cultivation density. This precaution is essential to address cumulative and synergistic effects, while also ensuring adherence to environmental carrying capacity, as outlined in BRASIL (2009).

Simplified licensing does come with certain restrictions. The project must not lead to the creation of new barriers in watercourses, and it must not be situated in a segment of the water body that experiences recurrent cyanobacteria blooms, as stipulated in Resolution No. 357/2005 (BRASIL, 2005). The precaution

is specifically geared towards preventing the degradation or decline in water quality, which poses increased risks to both human health and the ecosystem. Cyanobacteria can disrupt oxygen levels, introduce toxins into the water, alter turbidity levels, and affect the photic area of the watercourse.

Environmental permitting and its need for consistency may come into conflict with the aspiration to use aquaculture as a means of enhancing food security in resource-limited communities. This necessitates oversight from management bodies and inclusion programs to ensure that economic activities do not obstruct the ecological security sought through licensing, to the extent that it is perceived as a hindrance from the community's standpoint. For this reason, Resolution No. 413/2009 even allows for a streamlined environmental licensing process for small--scale ventures in densely populated areas with similar activities, in addition to a unified administrative licensing process for aquaculture parks.

Licensing is thus coordinated with the water permit's sectoral activities, as well as the sectoral activities impacting the production chain. In this regard, Article 11 of the Resolution stipulates that the licensing authority must require the entrepreneur to submit the documentation resulting from the procedures processed with the water management agencies. If the project is subject to preliminary environmental licensing, it must be accompanied by a prior statement regarding the request for water resource usage. The granting of the right to use water resources must be presented during the environmental operation license phase or in a single-stage environmental licensing process. However, if water usage has already commenced during the environmental installation license phase, the request for permitting may be presented at that point. Despite distinct requirements in the sectoral and environmental realms, the procedures are closely aligned to ensure the activity's compliance.

The federal sectoral standard on the use of waterbodies permits is laid out in Resolution No. 1,941, enacted on October 30, 2017, and issued by the National Water and Sanitation Agency. This Resolution not only outlines the measures for awarding permits but also addresses the possibility of their suspension, either partially or entirely. Given the multiple uses of water and the potential for scarcity or environmental inadequacy, entrepreneurs may face the risk of losing their water permits. Consequently, if an environmental license is denied or revoked, it invariably leads to the loss of the water permit.

Conversely, in scenarios where a preventive water rationing regime is declared due to scarcity, it may entail the partial or total suspension of aquaculture operations for a specified period. Communication between water sector bodies

and environmental agencies is paramount to ensure legal certainty and predictability for entrepreneurs. It also plays a crucial role in preventing safety hazards and damages concerning society as a whole.

Aquaculture, like any other activity reliant on natural resources, must carefully consider the carrying capacity limits of the impact area. The carrying capacity "encompasses the evaluation of the environmental resource's sustainability, considering both the human perspective and that of other living beings" (MOTA, 2009, p. 43). The environment has a threshold for the impact it can absorb without suffering degradation or losses in its ecological processes. Hence, ecology posits that carrying capacity is attained when "all incoming energy is essential to sustain all fundamental structures and functions" (ODUM; BARRETT, 2017, p. 128). The potential polluting consequences or environmental disruptions must be evaluated both upstream and downstream to gauge the levels of disruption resulting from human interventions.

It is not about limiting projects but rather ensuring that they are developed sustainably[3], meaning they can persist over time, as well as the natural resources they rely on. It is also necessary to evaluate:

> […] the variance between the standards set for classifying water used in cultivation and the chemical concentrations present in the upstream section, estimating this concentration after the mixing zone. This simplified licensing method could also be taken into account (BARROSO *et al.*, 2016, p. 28; our translation).

Due to ecological risks, Art. 18 of Resolution No. 413/2009 mandates the technical and impact analysis of the project. If a genuine technical need is identified, measures for effluent treatment and control must be implemented to ensure compliance with the permitted impact levels following the water body's class (BRASIL, 2009). Taking into account the severity of the species' characteristics, containment and prevention measures may be required to control the risk of specimens escaping and avoid harmful interference with naturally existing populations in the water body. These provisions should be incorporated into environmental conditions and tailored to the characteristics of the recipient projects.

Social and economic programs focused on social inclusion and economic development should determine technical and operational support, with the active involvement of public bodies. These programs are essential for establishing solid and consistent pathways for the sustainable exploitation of natural resources in

3 For an in-depth exploration of the legal and political dimensions of sustainable development, especially concerning its role in safeguarding intergenerational fundamental rights and its relationship with public policies, you may refer to the works of: Gomes and Ferreira (2017; 2018).

aquaculture. To achieve productive and economic growth, while simultaneously reducing social inequalities and fostering development pathways, effective information and training must be provided to social and economic actors willing to engage in this activity.

Data related to aquaculture underscore the significance of interconnecting regulatory frameworks with economic and productive dynamics to establish governing standards in Brazil. Aquaculture production data in Brazil are compiled by the Brazilian Institute of Geography and Statistics (Instituto Brasileiro de Geografia e Estatística, IBGE), a federal agency, through its annual report of the Municipal Livestock Survey. In 2020, Brazilian aquaculture production reached 551.9 thousand tons, with a gross production value of approximately BRL 5,900,000,000.00. The predominant species produced is tilapia, an exotic species of African origin, constituting approximately 62% of Brazilian production. The leading producing states include Paraná, São Paulo, Minas Gerais, Santa Catarina, and Pernambuco. Data from IBGE indicate a substantial production growth, exceeding 70% from 2013 to 2021. In monetary terms, the production value witnessed an increase of around 260% from 2013 to 2020 (IBGE, 2021).

This economic-social context underscores the profound relevance of the aquaculture industry and its impact on the Brazilian economy. By aligning its water and productive sectoral coordination with the environmental regulatory framework, sustainable continuity for the activity can be ensured, along with the associated social and economic benefits.

It is important to note that this growth is not limited to Brazil; it has a global dimension. According to data from the United Nations, "world aquaculture production of farmed aquatic animals grew on average at 5.3 percent per year between 2001-2018 […], whereas the growth was only 4 percent in 2017 and 3.2 percent in 2018" (FAO, 2020, p. 21). This growth should also be viewed in the context of its potential to mitigate food risks and increase income in areas with economic and social vulnerabilities for the resident population. Relatively modest investments in aquaculture have the potential to create income sources and stimulate local and regional economic development.

Along these lines, as stated by Bueno *et al.* (2014), the practice of aquaculture in federal and state watercourses can contribute to the development of regions and localities that are currently marginalized in the pathways of economic growth in the country. It can also invigorate those areas already in more advanced stages of productive scale. Among the main advantages of aquaculture is the "possibility of immediately starting production, low initial investment (compared to excavated

ponds or rigid structures), high level of intensification, easier management, among others" (BUENO *et al.*, 2014, p. 481; our translation).

The sustainable planning of such activities can play a pivotal role in poverty reduction, a critical factor in mitigating the exploitation and unsustainable use of natural resources as a whole. This is of significant importance. The social inclusion of population groups in the sustainable economy has the potential to eliminate or significantly reduce unsustainable practices in regions affected by ecological and social vulnerabilities.

In a study conducted by the United Nations, under the auspices of the Food and Agriculture Organization of the United Nations, alongside recognizing the social, economic, and food security benefits offered by aquaculture, it was explicitly emphasized that "maintaining the health of aquatic ecosystems is vital in order to sustainably meet the nutritional needs of a growing global population" (FAO, 2020, p. 138). Without a commitment to sustainability, aquaculture will not be able to develop over the long term. For this very reason, concerns about the expansion of aquaculture are accompanied by practices and programs aimed at mitigating the degradation of aquatic ecosystems and initiatives focused on the conservation and restoration of biodiversity (FAO, 2020, p. 140).

Environmental protection cannot afford to ignore these statistics and data. Sustainability should not be seen as an absolute safeguard for natural resources, as such a perspective could undermine the regulatory dynamics of Environmental Law. It is understood that sustainable production in cultivation areas can mitigate the exploitation's impacts over natural areas, thereby aiding the restoration of aquatic ecosystems and lessening the demands on ecological capacity for the provision of natural resources for nutritional, cultural, and social purposes. Successful aquaculture has far-reaching dietary effects on culture and society as a whole.

Increasing the availability of aquatic species as a food source can contribute to a decrease in the consumption of other foods, such as red meat, which could consequently lead to improvements in dietary patterns and a reduction in the environmental impacts stemming from livestock farming. In this context, the National Water and Sanitation Agency underscores that "The largest consumptive uses of water, on a global scale, are agricultural. In Brazil, which boasts some of the largest livestock herds globally, there is a substantial demand for water within the structures related to animal drinking, breeding, and environmental conditions" (BRASIL, 2019, p. 24; our translation).

A holistic ecological-economic perspective becomes particularly significant in this context. The economic assessment of environmental impact should not

be fractured or isolated. Instead, the ecological-economic impacts of aquaculture, but weighed against those arising from livestock farming. With that said, "there is no shortage of normative devices, there is no lack of theoretical foundations that support a new perspective of Environmental Law, the lacking is related to effective answers, lack of answeres that ensure" (BÖLTER; DERANI, 2018, p. 216).

Hence, controlled and managed increases in impacts within a particular field can, when approached in the broader context, lead to superior environmental benefits. In other words, the sustainable growth of aquaculture can result in a reduction in the impacts of livestock farming, the environmental effects of which have long been a topic of discussion, including issues such as deforestation in specific regions and the atmospheric pollution effects due to methane emissions.

Final considerations

Environmental legal analyses should not be conflated with either a relentless pursuit of economic feasibility for exploitation or preservation ideals founded on the ideal of an unbreachable safeguard. Environmental legal analyses are structured within the framework of legal provisions constitutionally grounded on sustainability principles, addressing societal needs and commitment to advancing levels of environmental quality that are favorable and progressive.

From this standpoint, the understanding of the regulatory framework for waterbodies management in aquaculture should align itself with the environmental regulatory framework. This integration should signal not opposition or confrontation but rather synchronicity and symbiosis. This integration should also be harmonized with sectoral development strategies and the governance of public goods, even when used by private projects.

Symbiosis, beyond its ecological connotation, means "living together" and implies coexistence. The interplay between the use of natural resources and the management of impact assessments to mitigate adverse effects while achieving environmental benefits and addressing societal needs requires that Decree No. 10,576/2020 be acknowledged as legitimate in its regulatory exercise.

It also requires that its systemic legitimacy adheres to the ecological demands on water quality and the impacts of potentially or effectively polluting activities, or those using natural resources, which are areas of expertise within the environmental agencies. Likewise, it must attend to the planning and management of water resources, considering availability and quantitative regulations. The specific domains of regulatory bodies overseeing multiple and quantitative water use and

the standardization and implementation of the National Environmental Policy (PNMA) are not isolated from each other.

The use of waterbodies and their suitability for assignment for aquaculture purposes comprise a regulatory framework that manages both the quantitative and qualitative use of water and has implications not only for direct environmental assets but also for comprehensive environmental impact assessments. It may represent productive substitutions that yield environmentally favorable outcomes. The legal framework is diverse and integrated, with the regulatory provisions specified in the assignment decree being limited to the sectoral context. These provisions align with the technical assessment levels of the National Water and Sanitation Agency to determine the granting and allocation of multiple uses. Therefore, aquaculture activities are subject to environmental impact assessments and, consequently, require environmental authorizations and licensing.

Environmental impact assessments and the associated environmental requirements can indeed vary depending on the regulations and policies of the licensing body, regardless of the ownership of the water bodies where aquaculture activities are conducted. Quantitative or operational management of multiple water uses does not, by itself, determine the specific federative entity responsible for assessing and granting authorization or environmental licenses. Environmental analysis is not a one-size-fits-all process.

The degree of impact of the aquaculture activity, its potential synergistic and cumulative effects, and other factors will determine the extent of restrictions, mitigation measures, and potential environmental compensation. This includes measures to prevent risks associated with waste dispersion and increased nutrient levels in watercourses. Scientific, socially beneficial, or economically significant activities will entail distinct frameworks for impact assessment and tolerability levels. These considerations will also depend on the size of the enterprise, whether it conforms as an aquaculture area or park, and the degree of impact on local and regional biodiversity.

Achieving economic success and maintaining production levels in aquaculture is contingent on regulatory foundations that are underpinned by considerations of carrying capacity and control of environmental impacts. The aim is to generate effective environmental, socio-environmental, and socioeconomic benefits rather than creating environmental liabilities that could compromise immediate economic gains from these activities.

Indeed, the assignment of waterbodies for aquaculture or any other purpose should not be viewed as a simple granting of territorial assets. Instead, it should

be understood as the delegation of the right to exploit a publicly owned natural resource. This delegation comes with significant implications for diffuse rights, where the ecological and social benefits play an influential role in the cooperative assessment of private economic gains.

The regulatory framework for public assets concerning waterbodies for consumptive water use necessitates coordination between usage regulations related to assignment and impact regulations based on the National Environmental Policy (PNMA), as well as regulations for multiple uses and allocation based on the National Water Resources Policy (PNRH).

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