Review

Challenges and Deficiencies in Wastewater Management: An Analysis of European Legislation (Directive 91/271/EEC)

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Challenges and Deficiencies in Wastewater Management: An Analysis of European Legislation (Directive 91/271/EEC)

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Abstract: This article critically examines existing wastewater management legislation, highlighting its detrimental impact on environmental and public health. It emphasizes the urgent need for a mentality shift among water managers, advocating responsible stewardship of water resources. By promoting collaboration between regulatory bodies and scientific communities, the article seeks tailored solutions for complex challenges. It underscores the necessity of integrating technological innovation, rigorous monitoring, and public engagement for sustainable management. Additionally, it calls for the implementation of easy-to-adopt technological solutions, alongside rigorous monitoring and financial support. Ultimately, the article advocates for a paradigm shift in wastewater management policies towards accountability, innovation, and environmental sustainability. Directives governing wastewater management in Europe, particularly in Spain, have faced scrutiny due to significant shortcomings. Legislation has inadvertently facilitated untreated or poorly treated wastewater discharge, resulting in widespread pollution. Despite EU efforts, punitive measures have proven ineffective, with fines often borne by the public sector, although private sector responsibility. The lack of robust monitoring mechanisms and technical support exacerbates the situation, perpetuating a regressive mindset among water managers. Urgent reforms are needed to enforce strict discharge prohibitions, promote reuse, and provide financial and technical assistance. However, systemic barriers and entrenched mentalities pose formidable challenges to meaningful change.

Keywords: european directive**;** eutrophication; sensible areas; wastewater management

1. Introduction

This report has been prepared to assist the European Commission in understanding the challenges associated with wastewater management and to contribute to the refinement of existing directives aimed at improving the quality of life for European Union citizens. It offers a comprehensive review of the introduction and articles comprising the legislation, with a focus on evaluating the impact of these directives on wastewater management in Spain and other Member States.

The directive's philosophy reflects a general lack of understanding of wastewater management and its implications for public health and aquatic environments. This widespread lack of awareness has led to critical issues, with both coastal and inland waters suffering from adverse effects due to inadequate water body management and harmful pollution.

It appears that the advisors and jurists responsible for drafting this legislation either overlooked the deficiencies in wastewater management and associated technologies, which result in the continuous discharge of highly polluted effluents into the environment, or they deliberately designed a directive that absolves responsibility, granting water management companies significant leeway in treating pollution. A combination of both factors may offer the most plausible explanation for the directive's final outcome.

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Technical and scientific rationale for permitting discharges of varying degrees of treatment, especially in coastal areas, is based on two outdated assumptions: the infinite capacity of the sea and the instantaneous dilution process occurring throughout the marine volume. These assumptions, rooted in an 18th-century mentality, are also applied to continental waters without substantial support. These simplistic theories incorrectly depict the sea and other bodies of water as perfect cleansing agents, capable of rendering any effluent harmless to human health and marine or aquatic ecology. This perspective overlooks one of society's most pressing unresolved issues: wastewater management.

Another manifestation of inadequate awareness in water management is the stagnation of legislation over the past thirty years. The directive's underlying philosophy, discharge parameter limitations, regulatory oversight, and disconnect from real-world impacts remain unchanged. Consequently, water has not been accorded fundamental importance within the European Community, and compliance with this deficient and permissive directive has not been effectively monitored by the EU Commission, leaving individual countries to determine their own water policies.

This study highlights a disheartening reality: the current and foreseeable future provide little favorability for redirecting wastewater towards total reuse and eliminating polluting discharges. The directive fails to acknowledge wastewater as a carrier of diverse pollutants, focusing solely on organic matter. It establishes limits on effluent quality leaving wastewater treatment plants, mandating monitoring of two primary parameters: BOD5 and COD, with suspended solids concentration as an optional parameter.

The limit table offers two options: a fixed concentration limit of 25 mg/L for BOD5 and 125 mg/L for COD, alongside reduction percentage values of 70% to 90% for BOD5 and 75% for COD. However, this framework fosters ambiguities and facilitates the discharge of highly polluting effluents, as evidenced by BOD5 concentrations of up to 800 mg/L or even 1400 mg/L in certain locations, resulting in output values exceeding the defined limit of 25 mg/L. Similarly, minimum BOD5 concentrations of 300 mg/L yield output values between 30 and 90 mg/L, consistently surpassing the stipulated fixed limit.

Notably, secondary treatment output values outlined by the EU in a 1991 regulation were not incorporated into Spanish standards until Royal Decree 509/1996 of 15 March, nearly 25 years later. As previously discussed, the directive serves as the basis for national legislation, yet it fails to promote the enhancement of existing wastewater treatment systems, reuse and integrated water management, or the protection of health and the environment.

Eutrophication: Definition and Implications

Eutrophication definition forms the cornerstone of legislative development in wastewater management. According to the Act, eutrophication is defined as: "*the increase in the concentration of nutrients in water, particularly nitrogen and/or phosphorus compounds, leading to accelerated growth of algae and higher plant species, resulting in undesirable disturbances to the balance between organisms present in the water and the overall water quality.*"

This definition is central to understanding the significant issues associated with wastewater discharges. Eutrophication occurs when there are abnormal effects in the water body receiving the discharged nutrients. However, the determination of these abnormalities falls under the purview of water management authorities. To avoid the legal implications associated with nutrient discharges, these authorities may choose to remain unaware of such processes.

The absence of a designated authority responsible for identifying accelerated growth of primary producers exacerbates the problem. Public funding for research projects examining the effects of discharges is limited, as regulatory bodies often do not prioritize such endeavors. Furthermore, marine research institutions heavily rely on government grants, which may deter them from investigating areas that could conflict with political interests.

This situation is indicative of a phenomenon often referred to as political correctness, which has curtailed debates in academic and research settings on critical matters, including pervasive pollution from sewage discharges. Environmental concerns frequently evade societal attention. In instances

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where pollution levels become conspicuous, particularly within the tourism sector, it is typically the media that sounds the alarm. However, efforts to address such issues often involve mitigating media coverage rather than tackling the underlying problem, leaving environmental degradation unresolved.

Health complications among individuals exposed to sewage spills are a matter of concern. Medical professionals unequivocally attribute such ailments to direct contact with contaminated effluents. Instances of gastrointestinal illnesses are prevalent in Mediterranean regions during the summer months, often misattributed to foodborne pathogens. More severe cases involving antibiotic-resistant bacteria following recreational activities such as swimming are becoming increasingly conspicuous. Management responses frequently involve regulating media coverage rather than addressing the root causes.

Examining eutrophication further, several cases observed in the Canary Islands elucidate this phenomenon and its associated behaviors. The first case concerns the proliferation of *Lyngbya majuscula* in the Canary Islands. Despite recognition by European authorities of the continuous influx of sewage as highly problematic, there is reluctance to acknowledge the adverse effects of these discharges on coastal ecosystems, particularly regarding the abnormal growth of primary producers.

Extensive fields of this filamentous cyanophyte, resembling red algae, have spread across hectares of seabed at depths ranging from 10 to 30 meters. Due to their subaquatic habitat, these formations are not visible from beaches, nor do they typically manifest in visible accumulations observable from the shore, then there are not official recognition crises and subsequently there are not Eutrophication case. Nonetheless, their impact is profound within seagrass meadows, critical marine ecosystems in the Canary Islands. The aggressive nature of this cyanophyte, characterized by its filamentous structure, stinging capacity, and tendency to settle on the seabed, results in entanglement with and subsequent suffocation of *Cymodocea nodosa* plants, a dominant species within these meadows. []

Figure 1 illustrates the presence of cyanophyte fields of *Lyngbya majuscula*, on the sandy seabed and their detrimental impact on seagrass meadows, which are experiencing decline across the archipelago.

Figure 1. Lyngbya majuscula suffocating a seagrass meadow on the island of Lanzarote. (Photo by Rogelio Herrera).

A different case is the proliferation of (Trichodesmium erythraeum) on the Canary Islands coastal water surface, resulting in the formation of visible cream-like layers, poses a significant threat to beach quality and has garnered media attention. Authorities fail to acknowledge the relationship between wastewater discharges and the growth of primary producers, thereby denying the existence of eutrophication problems, although the non-consensus between the researchers.

A third case, always in Canary Islands, emergence of algae, such as Enteromorpha sp., (see Figure 2) at sewage outfall mouths and adjacent coastlines with inadequate or absent treatment, alongside sludge discharge, is unequivocally linked to heightened nutrient levels. This scenario aligns with the criteria outlined in prevailing definitions of eutrophication. However, even in such

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obvious cases, reports to European authorities are often not made, eliminating a Eutrophication incidence.

A compelling case study illustrating the pitfalls of the current definition is that of the Mar Menor. Initially, the ecosystem's response to substantial nutrient inputs favored tourism, as evidenced by clear waters, and limited primary producer growth restricted to the seabed. However, a shift in nutrient dynamics precipitated the onset of dense phytoplankton blooms. Consequently, discussions surrounding eutrophication ensued only when adverse effects on the tourism industry became apparent, highlighting the subjective nature of defining eutrophication based on its impacts on tourism.

Figure 2. *Enteromorpha sp*. growing in a wastewater discharge on coastal line.

Eutrophication is a complex phenomenon that requires extensive research to fully understand its origins and mechanisms. However, the lack of funding for such research initiatives by authorities impedes the establishment of clear links between sewage discharges and the proliferation of algae. Investigating these relationships is inherently challenging and time-consuming, as is the case with many coastal marine processes.

Establishing an unequivocal link between growth and sewage discharges is challenging. Any research or theory can always be subject to questioning unless supported by isotopic analyses—analyses that are unlikely to receive funding, and even if funded, finding a laboratory to conduct them would pose difficulties. Moreover, even if a researcher definitively proves the link, determining whether it constitutes a process of eutrophication remains uncertain, if the administration fails to inform the EU, despite the potential for fines. EU lacks the capacity and willingness to monitor or challenge reports from each member state. Consequently, there are virtually no cases of eutrophication documented within the EU.

The objective of this article is not to delve into the origins of these growths, but rather to underscore the repercussions of legislative shortcomings that hinder the attribution of responsibility for eutrophication phenomena.

The scenario mirrors that of other nations, exemplified by recent incidents exposed within the EU where athletes experienced adverse effects due to subpar water quality. The Parisian scenario surrounding the 2024 Olympic Games underscores the widespread nature of dumping practices, revealing society's current inadequacy in effectively managing wastewater. Similarly, revelations regarding the Thames were brought to light through observations by trial rowers. The key disparity lies in England's proactive approach, where the utilization of sensors has provided insights into the extent of the issue, acknowledging the continuous nature of discharges and the indisputable challenges in management. The cases are everywhere, but they only become a problem when the media realizes the situation (see Figure 3).

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Figure 3. Some examples of developed countries with serious and continuous problems with wastewater management.

Sensitive Areas: Definition and Implications

The definition of "less sensitive areas" also requires careful examination. Coastal zones should be considered accumulation areas for pollutants, making to lakes. This has been consistently demonstrated through years of study, particularly in legislative cases that highlight the potential for coastal pollution to spread without complete dilution from one country or region to another, acknowledging significant accumulation capacity. [1–3]

The proliferation of primary producers in coastal areas is closely linked to environments with elevated nutrient levels. In the Canary Islands, such growth occurs along open coastlines and responds promptly to nutrient discharges and other pollutants. Fluid mechanics clearly explain these natural processes: coastal zones operate independently of oceanic areas. Within coastal zones, dynamics typically align parallel to the coast, driven towards the shore by wave and wind action.

Few forces disperse wastewater discharged at varying depths, causing it to rise and move towards the surface. Consequently, coastlines act as accumulation zones for both nutrients and other pollutants. Therefore, they should be classified as sensitive areas, particularly in naturally oligotrophic waters like those surrounding the Macaronesia archipelagos. Here, ecosystems react swiftly to nutrient inputs, as they are ill-prepared for changes in turbidity, nutrient levels, or chronic alterations such as land-sea sewage discharges. Additionally, other coastal areas react instantaneously to any increase in nutrients, though there seems to be no intention to recognize these negative effects.

There are almost infinite scientific articles to support every assertion in this legislative overview, in order to simplify the bibliography organization, we suggest a recompilation we made last year with a resume of substantial references were you can found relevant references for every issue about wastewater. [4]

2. Specific Comments.

2.1. Comments About Directive Introduction

Sixth paragraph

"Whereas pollution due to insufficient treatment of wastewater in one Member State often influences other Member States' waters, whereas in accordance with Article l 30r, action at Community level is necessary."

This paragraph clearly recognizes that coastal waters can be affected by sewage discharges, sea does not have an infinite dilution capacity, and there can be accumulation of pollutants in coastal waters which can impact other remote coastal areas.

Seventh & Eighth paragraph

"Whereas to prevent the environment from being adversely affected by the disposal of insufficiently treated urban wastewater, there is a general need for secondary treatment of urban wastewater."

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“Whereas it is necessary in sensitive areas to require more stringent treatment, whereas in some less sensitive areas a primary treatment could be considered appropriate.”

These paragraphs refer to a singular wastewater treatment technology, primary and secondary treatment, defining centralized wastewater management. The limitations of this technology are evident in the poor state of open coastal waters, contributing significantly to the current decline in sanitary and environmental conditions of water bodies. The exclusive focus on this technology disregards other potential solutions, such as more efficient decentralized management systems, which could lead to considerable investment savings and reduced maintenance, while ensuring high-quality treated wastewater.

The absence of periodic updates to incorporate technological advancements makes the directive regressive in terms of health and environmental awareness. Secondary treatment, while an improvement over primary treatment, still exhibits very high variability depending on local conditions, necessitating continuous monitoring with automated sensors to understand the overall impact on water bodies.

Ninth paragraph:

"Whereas the recycling of sludge produced by wastewater treatment should be encouraged; that the discharge of sludge into surface water should be phased out."

The paragraph hints at the need to encourage recycling of sludge produced by wastewater treatment and phase out its discharge into surface water. However, this falls short of addressing the significant harm associated with treatment plant sludges. Eliminating this practice requires stronger determination, including proper surveillance, technical assistance, and strict penalties for non-compliance.

2.2. Comments About Body of Law

Article 1

"... The aim of the directive is to protect the environment from the negative effects of discharges of wastewater."

The directive's primary objective is to shield the environment from the detrimental impacts of wastewater discharges, necessitating a thorough examination of the substantial health hazards and environmental repercussions stemming from inadequate wastewater management practices.

Article 3

1. Member States shall ensure that all agglomerations are provided with collecting systems for urban wastewater,

- at the latest by 31 December 2000 for those with a population equivalent (p.e.) of more than 15 000, and
- at the latest by 31 December 2005 for those with a

p.e. of between 2 000 and 15 000.

Spain and other EU member states notably lag behind in meeting the stipulated deadlines, indicating a significant deficit in effective monitoring and surveillance by EU regulatory bodies.

Article 4.

"Member States shall ensure that urban wastewater entering collection systems is subject to secondary treatment or equivalent treatment before discharge in the following circumstances:"

Spain's failure to adhere to secondary wastewater treatment mandates is glaring, prompting the European Commission to take punitive action against Spain for its non-compliance.

2. "... High Mountain municipalities (more than 1500 m above sea level) where it is difficult to apply effective treatment due to low temperatures may be subjected to less rigorous treatment, provided that there are detailed studies indicating that such discharges do not harm the environment."

This paragraph contradicts the first article of the directive and intuit and foresee a hypothetical scenario where a discharge of untreated wastewater does not produce impact. This is constantly repeated in all water legislation and, of course, in this directive, i.e., they always leave open the

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possibility of not conducting purification if the discharges of untreated wastewater do not cause any damage to the environment.

Thus, in the case of municipalities located more than 1500 meters above sea level, it opens up the possibility of discharging untreated wastewater, providing for a hypothetical scenario in which these discharges do not have any impact on the environment.

It should not be forgotten that, over the last two decades or so, the technology for treating wastewater under these conditions has been developed with every guarantee.

Article 5

This article delineates the criteria for wastewater treatment in sensitive areas, including the identification and periodic reassessment of these regions, as well as the deadlines for attaining more stringent treatment standards.

Thus, it analyses the deadlines for defining sensitive areas in each Member State, assigning more restrictive values in terms of wastewater discharges. For "*phosphorus values of 2 and 1 mg/l and for total nitrogen values of 15 and 10 mg/l are set, depending on the size of the urban agglomeration: the highest values for municipalities with between 10,000 and 100,000 inhabitants and the lowest values for municipalities with more than 100,000 inhabitants*". As in the previous table of limitations, a limit is left open depending on the percentage of reduction with respect to the quality of the incoming water, with the uncertainly associated at these kinds of limits produce.

Definition of sensitive areas is given in Annex II, in section A, and this definition is rather peculiar. Subparagraph "a" reads: "(a) Natural freshwater lakes, other freshwater media, estuaries and coastal waters that are eutrophic or could become eutrophic in the near future if protective measures are not taken."

This definition covers any type of water, as all of them are susceptible to eutrophic discharges from urban agglomerations. The evidence is clear, and all Spanish coasts suffer continuous eutrophication processes if we consider the definition offered by the directive itself.

Broadly speaking, and discussed at the introduction, all wastewater discharges with varying degrees of purification lead to an increase of nutrients in water. Nitrogen, phosphorus, silica compounds, iron, and the whole list of nutrients are greatly added in these effluents since they have a concentration several orders of magnitude higher than in most natural processes, due to the pollution load they carry. Then

Eutrophication is the increase of nutrients that will always favor the undesired progression of primary production. In addition, these nutrients are accompanied by vitamins, amino acids and various types of drugs that further increase growth.

Speaking of which, wastewater discharges with different degrees of purification alter the quality of the water they affect, producing an imbalance among the organisms present. A continuous discharge in any watercourse and especially in coastal waters produces an impact at the very moment as the initial conditions are modified. Moreover, the ecological system does not recover until the conditions modified by the discharge are no longer present. Hence, the discharge alters the water column and causes an accumulation of pollutants in sediments which, in turn, alters the aquatic environment until they are removed. Therefore, it is not sufficient to simply eliminate the spill, but the sediments must also be treated and/or removed. [4]

Once the initial conditions in water and sediment quality have been restored, it is necessary to analyze the change in ecological structure to see what changes have occurred: change in milieu conditions will have favored some opportunistic species (few) and disadvantaged others (most). Consequently, the process of recovery of the ecology of the area may be irreversible, as opportunistic species may become established for a long period of time.[4]

Section B defines "less sensitive areas", and says that they will be fewer sensitive "when the discharge of wastewater does not have negative effects on the environment..."

In effect, it assumes that there are wastewater discharges that have no negative effects as we have seen this conception throughout the document. Moreover, it implies that the discharge of wastewater, *"can have beneficial effects"*.

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It continues: "Member States shall take into account the risk that the discharged cargo may move to adjacent areas and be harmful to the environment."

It is insisted that a discharge in a given area may be harmful while in others it may not, which does not have logical sense. Basically, the lack of knowledge of marine processes, as well as the lack of consideration of water quality in the regulations, greatly favors the pollution impunity of the administrations and private companies that manage water.

Indeed, it is also recognized that dilution is neither instantaneous nor harmless to the environment, as pollutants can move with coastal water currents and carriage their harmful capacity with them, therefore there is an impact when spills occur in coastal waters.

Article 5 (8) :"For the purposes of this Directive, a Member State shall not designate sensitive areas when it applies the treatment provided for in paragraph 2 throughout its territory. 3 and 4."

This section presents a noteworthy proposition, suggesting that sensitive areas need not be designated if comprehensive treatment measures are implemented nationwide. However, this option should have been the directive's foundational premise, acknowledging the inherent sensitivity of all areas and necessitating stringent discharge limitations across the board.

In essence, the directive's laxity has enabled widespread non-compliance due to inadequate enforcement mechanisms and the absence of clear accountability measures. Consequently, governments, exemplified by Spain, minimize sensitive area designations, perpetuating environmental degradation. The classification of "less sensitive" waters overlooks the complexities of coastal ecosystems and underscores a systemic reluctance to invest in comprehensive monitoring and mitigation strategies, perpetuating a cycle of environmental neglect and regulatory impunity.

Determination of sensitive areas is left to the goodwill of governments which clearly, as in the case of Spain, do everything to reduce them to the minimum possible.

Finally, it defines “less sensitive” waters in the last section based on the fact that there are coastal waters with good water exchange that do not have eutrophication or oxygen depletion. This paragraph specially, open the door to any discharge without responsibility, they consider that a place in open sea, (coastal area) there is not risk for the environment, because we cannot measure the evolution of dissolved oxygen in open coastal areas, leaving the decision as to whether it is susceptible to oxygen deficiencies to the plain eye of the person in charge without proper formation and direct conflict of interest with the water management responsible. The only way to measure the impact of a discharge, is a serious continuous monitoring system combining different measurements, numerical modelling, remote sensing etc., that no one want to implement in discharge area. A punctual measure of oxygen once, twice or several times a year does not give any information about the impact.

This paragraph scrutinizes the deadlines for delineating sensitive areas in each Member State, which entail stricter standards for wastewater discharge. The phosphorus and total nitrogen values specified, contingent upon urban agglomeration size, underscore the inherent uncertainty surrounding such limits and their implications. The definition of sensitive areas, as detailed in Annex II, subsection (a), encompasses a broad spectrum of water bodies susceptible to eutrophication, mirroring the directive's own definition of the phenomenon. Notably, wastewater discharges introduce a myriad of nutrients into water bodies, exacerbating nutrients concentration and altering ecological dynamics. Moreover, the directive's classification of small agglomerations' discharges as inconsequential overlooks their cumulative impact and fails to account for synergistic effects. Subsection (ii) further exemplifies this oversight, minimizing the significance of effluent impact in certain areas based solely on agglomeration size. [4]

The subsequent delineation of "less sensitive areas" posits a questionable assumption that wastewater discharges may yield beneficial effects and underscores a pervasive lack of understanding regarding marine processes and water quality regulation. The acknowledgment of the potential for pollutants to propagate through coastal waters accentuates the fallacy of relying on dilution as a panacea.

Article 6

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Paragraph 2 determines that discharges into coastal waters for agglomerations of up to 150,000 equivalent inhabitants may be subject to "*less stringent*" treatment if they undergo primary treatment, and if "*there are comprehensive studies indicating that such discharges will not have adverse effects on the environment*."

A primary treatment is a very simple process which only serves to protect the installations and does not generate relevant pollution reduction, which, as it is also not monitored, has served as a justification and incentive for the discharge of raw sewage along the entire coastline of Member States.

This article discusses the identification of less sensitive areas and the treatment of urban wastewater discharges. It allows Member States to identify less sensitive areas by a certain deadline if they meet the criteria outlined in Annex II. Additionally, it permits urban wastewater discharges from certain population sizes to receive less stringent treatment if they undergo at least primary treatment and comprehensive studies indicate no adverse environmental effects. Member States are required to provide relevant information to the Commission, and if conditions are not met, the Commission can propose appropriate measures to the Council. The identification of less sensitive areas must be reviewed regularly, and areas no longer designated as such must meet the requirements of Articles 4 and 5 within seven years.

Article 7

It mandates that urban wastewater entering collecting systems must undergo appropriate treatment before discharge in specific cases by a certain deadline. However, countries like Spain are far from achieving this requirement, as oversight and technical support from the EU Commission seem lacking.

Article 8

This article allows Member States to request a longer compliance period for Article 4 due to technical problems and for specific population groups. However, technology can solve wastewater problems relatively quickly with adequate financial support, rendering delays unnecessary. [5]

The Commission must examine such requests and take appropriate measures, but there is a persistent focus on technical issues despite potential solutions being readily available.

In exceptional circumstances, discharges into less sensitive areas may undergo less stringent treatment, subject to Commission approval. However, the Directive fails to establish clear criteria for determining "*environmental benefits*," leaving decisions ambiguous and potentially prone to exploitation. The gap in oversight results in EU institutions resorting to fines rather than devising effective plans to address the problem.

Article 11

It requires Member States to ensure that industrial wastewater discharges are regulated and authorized by competent authorities or bodies before a certain deadline.

Section 2 of this article, lays out regulations and specific authorizations for industrial wastewater, emphasizing the importance of separating industrial and urban wastewater. However, in Spain, the discharge of industrial wastewater into collecting systems is common due to lax surveillance and the lack of specific treatment for industrial areas. Hospital discharges into urban sewage systems pose a significant sanitary concern, highlighting the need for decentralized wastewater treatment in industries.

Article 12

It addresses the reuse of treated wastewater and the disposal routes to minimize adverse environmental effects. Competent authorities must ensure that the disposal of wastewater from urban treatment plants complies with regulations and specific authorizations. However, the limited capacity and shortcomings of centralized treatment plants raise concerns about the reuse of treated wastewater and sludge, which have caused worrying situations in Spain and potentially other EU member states.

Article 13

It dictates that biodegradable industrial wastewater from certain sectors must meet specific conditions before discharge to receiving waters. However, Spain's failure to meet deadlines has led

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to critical discharges, disrupting bacterial equilibrium and secondary treatment processes in centralized plants. Consequently, untreated contents are discharged into surface, inland, or marine waters, posing serious environmental and health risks.

Overall, the directives outlined in Articles 6 to 13 highlight the complexities and challenges associated with wastewater management and pollution control within the European Union. While efforts are made to establish standards and regulations for wastewater treatment and discharge, significant gaps persist in implementation, monitoring, and enforcement. Addressing these gaps requires a holistic approach that integrates scientific knowledge, technological innovation, and robust regulatory frameworks to ensure the protection of water resources and public health across Member States.

Article 14

addresses the management of sludge arising from wastewater treatment, emphasizing the importance of reusing sludge whenever appropriate while minimizing adverse environmental effects. However, the directive's language regarding sludge reuse lacks specificity, leading to varied and often inadequate reuse practices, such as fertilization in agricultural fields, without proper consideration of the sludge's hazardous nature. Without appropriate treatment, sludge reuse can pose significant health, agricultural, and environmental risks, as evidenced by numerous reported cases.

Furthermore, the directive's provisions regarding the disposal of sludge from urban wastewater treatment plants reveal systemic shortcomings in wastewater management practices. Despite significant investments in wastewater infrastructure, including treatment plants and extensive sewage networks, the prevailing solution until 1998 was simply to discharge treated water and sludge into water bodies. This approach not only fails to address the root cause of pollution but also perpetuates environmental and sanitary hazards, including foul odors and the proliferation of pests.

Article 15

It outlines monitoring requirements for urban wastewater treatment plants and sludge disposal activities to ensure compliance with regulatory standards and assess environmental impacts. However, ineffective monitoring and oversight remain pervasive challenges across many treatment plants, hindering efforts to accurately assess pollution levels and mitigate adverse environmental effects. The lack of reliable data on sludge composition and disposal practices further compounds these challenges, impeding comprehensive pollution control measures.

Moreover, the directive's provisions on reporting and information sharing between Member States and the European Commission underscore significant gaps in communication and coordination. While Member States are required to publish situation reports on wastewater and sludge disposal every two years, the quality and consistency of these reports vary widely, limiting the Commission's ability to effectively assess the environmental impacts of sludge management practices. In Spain and potentially other Member States, these communication gaps have resulted in a lack of comprehensive information on the state of sludge and wastewater management, hindering efforts to address pollution effectively.

In conclusion, the directives on sludge management highlight critical deficiencies in wastewater treatment and pollution control practices within the European Union. Addressing these deficiencies requires a coordinated approach that integrates robust regulatory frameworks, effective monitoring and enforcement mechanisms, and enhanced communication and collaboration between Member States and the European Commission. By prioritizing environmental sustainability and public health, policymakers can work towards more effective and equitable wastewater management strategies across the EU.

Article 16

This is a critical point, there is a huge interconnection gap between the Member States and the European Commission. At least in the Spanish case, the Commission really lacks sufficient information on the actual state of sludge and wastewater management and on the pollution caused to the environment by these hazardous wastes.

Article 17

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The methods and formats for reporting on national programmes were to be determined through the procedure outlined in Article 18. Any amendments to these methods and formats were to follow the same procedure.

The Commission was tasked with reviewing and assessing the information received pursuant to paragraphs 2 and 3 above every two years and publishing a report on it.

Once again, this regulation left the European Commission without a mechanism to verify the information provided by the Member States. As evidenced by the Spanish case, it lacked even an approximate assessment of the pollution or health impact resulting from wastewater management in the Member States. Essentially, the European Commission's oversight was a bureaucratic process lacking in substantive content. The limited information available from other countries, such as France, Belgium, former Member UK, etc., paints a similarly unflattering picture, not significantly different from the situation in Spain.

Article 18

The Commission would be assisted by a committee composed of representatives from the Member States, chaired by a Commission representative.

The Commission representative would present a draft of the measures to be taken to the committee. The committee would deliver its opinion on the draft within a specified time frame, determined by the chairman based on the urgency of the matter. The opinion would be delivered by the majority outlined in Article 148(2) of the Treaty in cases where the Council is required to adopt decisions based on a proposal from the Commission. The votes of the Member States' representatives within the committee would be weighted according to the provisions of that Article. The chairman would not vote.

(a) The Commission would adopt the envisaged measures if they aligned with the committee's opinion.

(b) If the envisaged measures did not align with the committee's opinion, or if no opinion was delivered, the Commission would promptly submit a proposal to the Council regarding the measures to be taken. The Council would then act by a qualified majority.

If, after three months from the referral date to the Council, no action had been taken, the proposed measures would be adopted by the Commission, except if the Council had rejected the measures by a simple majority.

Article 19

Member States were required to enact the laws, regulations, and administrative provisions necessary to comply with this Directive by no later than 30 June 1993. They were also obligated to promptly inform the Commission thereof.

When Member States adopted the measures referred to in paragraph 1, they were to include a reference to this Directive or accompany them with such a reference upon their official publication. The methods of making such a reference were to be determined by the Member States.

Member States were to communicate to the Commission the texts of the main provisions of national law adopted in the field governed by this Directive.

The current situation in Spain demonstrates a lack of effective monitoring, other Members does not show a very different situation. (see Figure 3)

2.3. Comments About Anexes

2.3.1. Annex I. Requirements for Urban Wastewater

A. Collecting systems.

Collecting systems must consider wastewater treatment requirements. The design, construction, and maintenance should align with the latest technical knowledge without incurring excessive costs, particularly concerning:

- *Volume and characteristics of urban wastewater, aiming to prevent leaks.*
- *Mitigation of pollution in receiving waters due to stormwater overflows.*

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This paragraph underscores the urgent need for technological and knowledge updates in wastewater treatment and management. However, the lack of effective control and guidance on new technologies has led to stagnation in the treatment systems, with minimal changes over the past century.

The challenge lies in implementing new technologies when legislation remains unchanged for over three decades and shows no intent to adapt to technological advancements, evolving management practices, or emerging research on impacts. This highlights a concerning lack of sanitation and environmental awareness within the EU Commission.

A robust legislative framework requires constant updates to incorporate new research and development, fostering continual improvement in the sector. The phrase "*not entailing excessive costs*" reflects the regulation's priority on cost-saving rather than ensuring proper effluent treatment, hindering significant technological advancements. Notably, new technologies offer savings of 80-90% in both initial investment and maintenance, yet the regulation fails to incentivize technological improvements.

The issue of leaks is exacerbated by centralized management, where oversight is challenging due to the extensive network of sewer conduits. Estimates suggest significant effluent leakage, from a minimum of about 5-8%, reaching up to 50-60% of the total volume, posing environmental risks. []

Furthermore, centralized management exacerbates pollution from stormwater overflows, a challenge that decentralized management could address more effectively.

B. Discharge from urban wastewater treatment plants to receiving waters.

Section 1. Wastewater treatment plants should allow for the collection of representative samples from incoming wastewater and treated effluent before discharge.

Centralized treatment plants typically lack flexibility in design, hindering modifications to accommodate varying effluent characteristics.

Section 2. Discharges from urban wastewater treatment plants subject to treatment according to Articles 4 and 5 must meet the requirements outlined in Table 1.

Continuous monitoring with sensors integrated into plant processes and connected to water authorities and the public is essential to gather accurate data on discharge quantity and quality. Current monitoring and maintenance efforts are inadequate considering the significant financial investments in water management.

Section 3. Discharges from urban wastewater treatment plants to sensitive areas susceptible to eutrophication, as identified in Annex II.A (a), must meet additional requirements specified in Table 2.

While eutrophication is a well-recognized impact of wastewater, it is not the sole concern. There are various other impacts, notably on public health. Regardless of the water type, wastewater discharges contribute to eutrophication. However, water authorities often fail to identify or acknowledge these effects.

Section 4. More stringent requirements may be necessary to ensure compliance with relevant Directives for receiving waters.

Section 5. Discharge points for urban wastewater should be selected, as far as possible, to minimize their impact on receiving waters whenever possible.

The recent consensus acknowledges the necessity of discharge points, but "*minimizing the effects*" often translates to "*relocate the discharge as far as possible*" depending on voluntary efforts to measure and mitigate environmental impacts.

C. Industrial wastewater

“Industrial wastewater entering collecting systems and urban wastewater treatment plants shall be subject to such pre-treatment as is required in order to:

protect the health of staff working in collecting systems and treatment plants, ensure that collecting systems, wastewater treatment plants and associated equipment are not damaged, ensure that the operation of the wastewater treatment plant and the treatment of sludge are not impeded, ensure that discharges from the treatment plants do not adversely affect the environment, or prevent

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receiving water from complying with other Community Directives, ensure that sludge can be disposed of safety in an environmentally acceptable manner."

The same tale, if there is not a close control industrial wastewater discharges directly in the collecting systems. There is not specific treatment in, for example, hospitals, small workshops, etc. located in the middle of the cities, but even in the industrial polygons the discharges go directly to the urban sewerage, in best cases. There are some cases with specific depuration, even in these cases there is not control, and remains a long way to achieve the objective.

D. Reference methods for monitoring and evaluation of results.

"1. Member States shall ensure that a monitoring method is applied which corresponds at least with the level of requirements described below."

However, the lack of reliable data on wastewater management results, including the quality and quantity of discharges, sludge management, treatment plant failures, treated wastewater volume, and impact on water bodies and public health, remains a significant challenge. Instances in regions like the Canary Islands, Madrid, and Mar Menor highlight the considerable disparity between the information provided to the EU Commission and the actual situation on the ground. Similar issues are prevalent in other countries, as evidenced by the struggles faced by Paris in cleaning up its rivers for the 2024 Olympics and the ongoing challenges with the Thames. While alternative monitoring methods may be utilized if they demonstrate equivalent results, Member States must furnish the Commission with all pertinent information regarding the chosen method. If the Commission deems the conditions outlined in the directive are not met, it will propose appropriate measures to the Council. (See Figure 3).

Alternative methods to those mentioned in paragraphs 2.; 3 and 4 may be used provided that it can be demonstrated that equivalent results are obtained.

Member States shall provide the Commission with all relevant information concerning the applied method. If the Commission considers that the conditions set out in paragraphs 2, 3 and 4 are not met, it will submit an appropriate proposal to the Council.

2. Flow-proportional or time-based 24-hour samples shall be collected at the same well-defined point in the outlet and if necessary, in the inlet of the treatment plant in order to monitor compliance with the requirements for discharged wastewater laid down in this Directive.

However, the efficacy of such sampling hinges on independent oversight, which has been lacking in practice. To ensure sample integrity, international laboratory best practices must be strictly adhered to.

3. The minimum annual number of samples shall be determined according to the size of the treatment plant and be collected at regular intervals during the year:

- 2 000 to 9 999p. e.: 12 samples during the first year.

four samples in subsequent years, if it can be shown that the water during the first year complies with the provisions of the Directive; if one sample of the four fails, 12 samples must be taken in the year that follows.

10 000 to 49 999 p. e.: 12 samples.

50 000 p. e. or over: 24 samples.

The minimum annual number of samples should be determined based on treatment plant size and collected at regular intervals throughout the year. However, this approach may be inadequate given the fluctuating quality and quantity of effluent in centralized treatment plants. Continuous monitoring with sensors directly connected to responsible authorities, ensuring automated data storage without the possibility of manipulation, offers a more reliable solution, at a fraction of the cost of massive centralized treatment plants.

4. The treated wastewater shall be assumed to conform to the relevant parameters if, for each relevant parameter considered individually, samples of the water show that it complies with the relevant para- metric value in the following way:

(a) for the parameters specified in Table I and Article 2 (7), a maximum number of samples which are allowed to fail the requirements, expressed in concentrations and/or percentage reductions in Table I and Article 2 (7), is specified in Table 3;

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(b) for the parameters of Table 1 expressed in concentrations, the failing samples taken under normal operating conditions must not deviate from the parametric values by more than 100 %. For the parametric values in concentration relating to total suspended solids deviations of up to 150 % may be accepted.

(c) for those parameters specified in Table 2 the annual mean of the samples for each parameter shall conform to the relevant parametric values.

Alternative monitoring methods may be used if equivalent results are demonstrated, but current sampling methods are ineffective. Continuous monitoring with sensors is necessary for accurate assessment. The proposed annual sampling method is inadequate for dynamic of centralized treatment plants.

5. Extreme values for the water quality in question shall not be taken into consideration when they are the result of unusual situations such as those due to heavy rain.

Assumptions about treated wastewater quality should be based on rigorous standards, accounting for unusual situations like heavy rain. “Heavy rain” is a parameter that should be defined, since currently, it is an excuse used to justify any discharge from the treatment plants, in the event of any minimal precipitation.

Decentralized wastewater management avoids this problem as rainwater does not interfere with the treatment process.

Table 1 Requirements for discharges from urban wastewater treatment plants subject to Articles 4 and 5 of the Directive. The values for concentration or for the percentage of reduction shall apply.

Table 2. : Requirements for discharges from urban wastewater treatment plants to sensitive areas which are subject to eutrophication as identified in Annex II.A (a). One or both parameters may be applied depending on the local situation. The values for concentration or for the percentage of reduction shall apply.

The variation in discharge limits for different agglomerations underscores the need for a uniform standard without the loophole of percentage reduction. This highlights the limitations of traditional technology, which struggles even more with treating smaller human agglomerations, a challenge that could be addressed by embracing alternative technologies.

Table 3. Maximum permitted number of samples which fail to conform.

Another assistance provided to wastewater management companies or responsible parties comes in the form of an easy escape route in the event of an official non-conformity or an external complaint.

2.3.2. Annex II. Criteria for Identification of Sensitive and Less Sensitive Areas

The concept of categorizing areas based on the fragility of water bodies represents a step toward facilitating discharges, as the "open sea" is often viewed as a convenient repository for all kinds of pollution. It's seen as a perfect location due to the belief that the sea acts as a natural cleansing agent, capable of magically purifying residues.

However, the true criterion for determining the sensitivity of water bodies lies in how readily apparent the impacts of wastewater pollution will be to the public. In open seas, assessing the impact becomes exceedingly challenging, as it's difficult to control or monitor discharges from afar. At night, when visibility is limited, clandestine pollution becomes even easier to execute.

Despite the prevailing notion that the sea has an infinite capacity to dilute pollution, the observable impact of discharges is undeniable.

Already demonstrated several times in the preceding articles and indicated in the introductory paragraphs (sixth and seventh), open coastal areas represent a finite water body that must be recognized as a sensitive area. Where dilution is far away to be considered as infinite.

A. Less sensitive areas

A marine water body or area can be identified as a less sensitive area if the discharge of wastewater does not adversely affect the environment as a result of morphology, hydrology or specific hydraulic conditions which exist in that area.

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It is difficult to believe that “discharge of wastewater does not adversely affect the environment…”

In no way can a marine or continental water body be deemed as "less sensitive" if wastewater discharge does not have an adverse effect on the environment. Such a notion is contradicted by the established understanding of marine and continental water processes.

When identifying less sensitive areas, Member States shall take into account the risk that the discharged load may be transferred to adjacent areas where it can cause detrimental environmental effects. Member States shall recognize the presence of sensitive areas outside their national jurisdiction.

In this section, the potential of water bodies to accumulate pollution, which can be displaced without being diluted, such as coastal waters, is once again admitted, i.e. here it is justified that coastal waters should be considered as sensitive waters.

Unfortunately, Member States have often designated as few sensitive areas as possible, likely to minimize the regulatory burden. However, this approach exacerbates existing problems in already challenging environmental situations. A notable example is the Mar Menor coastal lagoon, which, despite its delicate ecosystem and restricted interchange with the Mediterranean coastal waters, has been classified by the Spanish Government as less sensitive. This classification is perplexing, especially considering that only a portion of the lagoon is deemed sensitive, highlighting the confusion and inconsistencies arising from this backward legislation.

The following elements shall be taken into consideration when identifying less sensitive areas:

open bays, estuaries and other coastal waters with a good water exchange and not subject to eutrophication or oxygen depletion or which are considered unlikely to become eutrophic or to develop oxygen depletion due to the discharge of urban wastewater.

The term "good water exchange" refers to coastal waters, such as open bays and estuaries, that experience effective circulation and mixing with surrounding waters. Essentially, these areas have a healthy flow of water that helps disperse pollutants and maintain water quality. However, the interpretation of what constitutes "good water exchange" may vary and could potentially be used as a loophole by water authorities to justify discharges.

Assessing factors like oxygen depletion and nutrient levels (eutrophication) in these areas requires sophisticated monitoring techniques. This involves continuous data collection over extended periods using a combination of methods such as numerical modeling, remote sensing, underwater and surface robotics, and other monitoring techniques.

Eutrophication, characterized by an increment of nutrients, invariably leads to environmental disturbances. While understanding its impact necessitates comprehensive research, the adverse effects are evident whenever there is a continuous influx of nutrients into the ecosystem. Therefore, labeling an area as "less sensitive" based solely on the assumption that it won't develop eutrophication is problematic, as the potential for environmental harm remains significant.

3. Conclusions

The conclusions drawn from the assessment of wastewater management in Europe, particularly in Spain, are overwhelmingly negative. Legislative irresponsibility and inadequate advisory mechanisms have directly contributed to the disastrous state of wastewater management. Current legislation not only supports but also promotes the discharge of untreated or poorly treated wastewater into the environment as a solution to wastewater management, leading to widespread pollution of surface watercourses, groundwater, and coastal waters across Spain.

Efforts by the EU to remediate the situation have proven largely ineffective, primarily focusing on economic sanctions that place the burden on public administrations while private companies continue to engage in illegal discharges. This negative synergy between administration and private entities impedes any meaningful improvement in management and obscures the true extent of the problem.

The EU's lack of acknowledgment and insufficient allocation of resources further exacerbate the crisis. Without a mechanism for effective monitoring and verification, the EU Commission is unable

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to accurately assess the situation. National governments are left responsible for wastewater management control, but the absence of effective oversight perpetuates the status quo.

Despite the goals outlined in the Directive's introduction, the EU Commission has failed to achieve meaningful progress, exemplified by the situation of the Seine River in Paris and the challenges faced in other countries like France and the UK. The absence of technical and scientific support to evaluate environmental impacts and propose tailored solutions further complicates matters.

The prevailing mentality among water managers that wastewater discharges are innocuous perpetuates the problem and will hinder efforts to rectify the situation for years to come. This regressive mindset must be addressed to enact meaningful change. Instead of facilitating easy discharge solutions, the EU Commission should prioritize technological advancements, mandate the reuse of treated wastewater and sludges, and provide closer supervision and support to member states.

The creation of a new directive is underway, but doubts persist regarding its ability to address the root problem. Without addressing systemic issues and fostering a shift in mentality, any new directive may fall short of effecting the necessary changes. Ultimately, the current directive perpetuates ignorance and avoidance of the problem, allowing wastewater management to continue with minimal responsibility.

Appendix A. European Directive 91/271/EEC adopted on 21 May 1991

We suggest you to include complete directive as an appendix

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