Vilnius University Press

Contents lists available at Vilnius University Press

Respectus Philologicus
2026, no. 49 (54), pp. 9–22

eISSN 2335-2388
DOI: http://dx.doi.org/10.15388/RESPECTUS.2026.49.1

Linguistic Modelling of the Eco-Economic WATER Concept in the EU Water Framework Directive

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Abstract. This study examines how the EU Water Framework Directive conceptualises WATER, highlighting an imbalance between definitional stability and functional representation within regulatory discourse. Although environmental discourse has been widely studied, systematic cognitive modelling of the EU water policy remains limited. The study aims to identify the semantic roles that shape the conceptual profile of the eco-economic WATER concept in the Water Framework Directive. The eco-economic WATER concept is defined as a linguistically encoded and institutionally framed construct integrating ecological values with economic considerations within EU environmental governance. It is hypothesised that the Directive constructs WATER as a hybrid entity dominated by the Formal and Constitutive Qualia roles, while the Agentive and Telic roles are selectively activated in specific governance contexts. The analysis applies frame-based and Qualia-based modelling within Generative Lexicon Theory, supported by frequency analysis and chi-square testing. The findings demonstrate a predominance of the Formal (32.5%) and Constitutive (31.2%) roles and lower frequencies of the Agentive (19.3%) and Telic (17.0%) roles, indicating a systematic conceptual asymmetry shaped by institutional and regulatory priorities. The Directive thus prioritises classificatory precision and measurable attributes of WATER, reinforcing a governance model centred on monitoring and regulatory control. Future research may extend Qualia-based modelling to more recent EU water policy instruments in order to trace shifts in conceptualisation across evolving governance frameworks.

Keywords: Water Framework Directive; eco-economic WATER concept; cognitive modelling; Qualia structure; EU water governance subdiscourse.

Submitted 19 August 2025 / **Accepted** 02 January 2026
Įteikta 2025 08 19 / **Priimta** 2026 01 02

Introduction

The growing number of global environmental problems, such as climate change, pollution, biodiversity loss, and water shortages, has heightened attention to how environmental ideas are formulated, explained, and shared in official and regulatory texts. Water, once seen mainly as a natural and life-sustaining element, is now more often viewed as a strategic resource important for both nature protection and economic safety (Allan, 2002). Within this evolving paradigm, the eco-economic WATER concept is treated here as a theoretically grounded, multidimensional construct that links ecological priorities with economic imperatives. In this study, it is defined as a linguistically encoded and institutionally shaped category that conceptualises WATER simultaneously as an ecological asset and an economic resource (Kovalyk, Tymochko, 2024). This framing integrates core ecological values, such as environmental quality and ecosystem integrity, with key economic considerations, including resource efficiency and cost recovery, and explains how WATER is classified, valued, and operationalised within the EU environmental governance (Kovalyk, Tymochko, 2024). Taken together, this definition establishes WATER as a hybrid regulatory concept rather than a purely natural resource. This shift underscores the need for detailed linguistic and cognitive analyses of how WATER is conceptualised across legal and environmental discourse.

At the same time, water governance has become an international issue. Water-related risks now go beyond national borders and are seen as important challenges for both environmental and economic security (Pahl-Wostl, Mostert, Tàbara, 2008). Managing freshwater and transboundary rivers is no longer only a technical task; it is now also a geopolitical and social priority. This reflects a growing understanding that society and nature are closely connected, which redefines traditional approaches to resource management and protection. Global policies now promote more responsible attitudes to water and support the development of environmental awareness at both individual and institutional levels (UN General Assembly, 2015). Against this background, the steady decline in water quality and its adverse effects on public health have elevated water to a central concern for policy-makers worldwide.

In this broader context, the European Union has become a leader in creating a common approach to water policy. Over the past two decades, the EU has built a strong legal system to deal with environmental and climate issues. A key point was the adoption of the Water Framework Directive (2000/60/EC), which introduced a river basin-based model and set clear goals for improving the ecological and chemical condition of all water bodies in the EU (European Parliament and the Council, 2000). By setting common quality standards and pollution thresholds, the Directive created a harmonised regulatory basis for water governance across the Member States.

Subsequent directives and regulations expanded this framework. The Floods Directive (2007/60/EC) required regular flood risk planning (European Parliament and the Council, 2007), while the Marine Strategy Framework Directive (2008/56/EC) set targets for protecting marine waters (European Parliament and the Council, 2008). Although the

Marine Directive did not meet its 2020 goals, it is now being revised to better match freshwater policies. Additionally, the Nature Restoration Regulation (2022) encourages ecosystem-based water management and supports biodiversity recovery (European Commission, 2022). Together, these instruments demonstrate the progressive expansion and diversification of the EU water governance framework.

The most recent step in the EU water policy is the European Water Resilience Strategy (COM (2025) 280 final), adopted in June 2025. This document offers a long-term plan based on three main pillars: restoring the water cycle, building a smart water economy, and securing clean, affordable water for everyone (European Commission, 2025). It encourages Member States to include water and climate resilience in their national plans by 2026 and proposes updates to key laws by 2027. By introducing new drought indicators and technical guidance, the Strategy signals a gradual shift toward resilience-oriented water governance in response to escalating pressures, such as water scarcity, pollution, and ecological degradation.

Following this EU policy trajectory, Ukraine, as an EU candidate country, has begun aligning its national water legislation with the Water Framework Directive. The Water Code of Ukraine (Verkhovna Rada of Ukraine, 1995) remains the central legal instrument governing water use and protection. Under the EU–Ukraine Association Agreement, Ukraine has committed to implementing EU water standards. This process marks a transition from a fragmented management system to an integrated river basin-based model, in which regulation is understood as a continuous and adaptive process. In this context, the harmonisation of legal definitions and terminological standards is a prerequisite for effective policy implementation and conceptual consistency. Adapting Ukraine's legal and terminological framework to EU norms is therefore essential for developing coherent water governance within the broader process of European integration.

This study builds on the authors' previous research on the environmental discourse in the EU water governance (Kovalyk, 2017; Kovalyk, Tymochko, 2020, 2023, 2024, 2025; Kovalyk, Tymochko, Demchuk, 2022). Extending these earlier findings, it examines the representation and internal conceptual architecture of the eco-economic WATER concept in the Water Framework Directive through a combined qualitative and quantitative approach. The analysis aims to identify the linguistic mechanisms through which the concept is encoded, structured, and prioritised in the Directive.

The working hypothesis is that the Directive constructs WATER as a hybrid eco-economic entity whose Qualia structure, interpreted within Generative Lexicon Theory, is dominated by the Formal and Constitutive roles, whereas the Agentive and Telic roles are selectively activated in specific governance contexts. This asymmetrical role distribution is interpreted as an effect of institutional rationality rather than a neutral semantic pattern.

The object of the study is the English subdiscourse of the EU water governance, as reflected in the text of the Water Framework Directive.

The study examines the linguistic and cognitive representation of the eco-economic WATER concept in the Directive, focusing on its conceptual framing, terminological structuring, and frequency patterns.

The research tasks are: (1) to identify and describe the key lexical, conceptual, and discursive features of the WATER concept in the Directive; (2) to model its internal cognitive structure using a Qualia approach; (3) to check the distribution and the weight of these features using frequency counts and statistical testing.

The empirical basis of the study is the original English text of the Water Framework Directive (2000/60/EC), which consists of approximately 29,000 words.

1. Methodological tools

This study employs a combined method to model the internal cognitive structure of the eco-economic WATER concept in the EU water governance subdiscourse. It brings together cognitive modelling, quantitative analysis, and statistical validation to ensure both analytical transparency and methodological reliability.

In previous research (Kovalyk, Tymochko, 2020), the WATER concept was studied using a frame-based approach grounded in propositional knowledge modelling. Based on the classification by the Ukrainian linguist Svitlana Zhabotynska (2018, 2019), five main frame types were identified: the Thing, Action, Possession, Identification, and Comparison frames. This earlier approach provided an initial cognitive mapping of the concept but did not address its internal semantic structuring in the regulatory discourse.

In the current study, a different theoretical framework is adopted, namely Generative Lexicon Theory (GL), developed by James Pustejovsky (1995). This theory offers a structured and semantically expressive model for lexical meaning, particularly suited to domains such as environmental governance, where concepts are functionally heterogeneous and institutionally constrained.

At the core of GL is the Qualia structure, which is composed of four interrelated semantic roles: (1) Formal Role – What kind of thing is it? (classification); (2) Constitutive Role – What is it made of? (components or structure); (3) Telic Role – What is it for? (purpose or use) and (4) Agentive Role – How did it come into being? (origin or production).

Each of these roles focuses on a different part of meaning. This multidimensional structure is especially relevant for the hybrid eco-economic concepts such as WATER, which operate across multiple domains and perform different discursive functions (Pustejovsky, 1995; Faber, León-Araúz, 2016).

The corpus annotation was conducted on the complete English text of the Water Framework Directive, with each occurrence of *water* analysed at the sentence level and assigned Qualia roles based on contextual semantic cues. Cases of co-activation were coded with multiple roles, while borderline instances were resolved through iterative comparison guided by interpretative consistency and the dominant regulatory function within the institutional discourse. This procedure ensured systematic and replicable role assignment across the corpus.

The methodological validity of this approach is further supported by its application in EcoLexicon, a multilingual environmental database created by the LexiCon research group (University of Granada). EcoLexicon combines frame-based theory and the Generative

Lexicon approach. It also uses a system called the Brandeis Semantic Ontology (BSO), which sorts concepts into entities, events, or properties and further categorises them as natural, artefactual, or complex (Pustejovsky et al., 2006). In this system, the Qualia roles help to define the links between concepts, making the meaning more organised and easier to use across languages and domains.

To operationalise the framework empirically, the study applies word-frequency analysis to identify the distribution of Qualia roles across the Directive. Frequency analysis highlights which semantic roles are most recurrent and how they are patterned throughout the text.

To assess the statistical significance of these patterns, the chi-square test (χ^2) is employed. This test examines whether observed frequency differences reflect random variation or indicate systematic conceptual preferences within the regulatory discourse.

Taken together, the integration of cognitive modelling (via the Qualia structure), quantitative analysis (via the frequency metrics), and statistical validation (via the chi-square test) provides a comprehensive methodology for investigating conceptual meaning. By combining qualitative interpretation with quantitative verification, the approach captures both the cognitive depth and the institutional function of the key lexical items (Pustejovsky, 1995; Pustejovsky, Ježek, 2008).

2. Conceptual modelling of the eco-economic WATER concept in the Water Framework Directive

2.1 Frame and qualia analysis of the WATER concept

Grounded in this integrated methodology, the present section applies a combined frame-based and Qualia-structured approach to the analysis of the WATER concept as encoded in the Water Framework Directive (throughout this paper, WATER in capitals denotes the abstract, cognitively modelled concept, whereas *water* in lower case refers to the lexical item) (WFD; 2000/60/EC). Drawing on Generative Lexicon Theory (Pustejovsky, 1995), each occurrence of the lexical item *water* in the Directive is treated as a context-dependent example of deeper cognitive structures. This approach enables the systematic reconstruction of the concept's functional, structural, and ontological profiling within the EU environmental policy.

As Pustejovsky and Ježek (2008) remark, each Qualia role corresponds to a distinct question regarding the ontological nature, function, or origin of a lexical item. In line with this view, the analysis classifies all occurrences of *water* in the Directive according to the four Qualia roles, each representing a distinct conceptual role: (1) **Formal Role** (What kind of thing is it?) captures definitional features and taxonomic categories; (2) **Constitutive Role** (What is it made of?) describes internal composition, including physical and chemical properties; (3) **Agentive Role** (How did it come into being?) indicates processes of origin or transformation; (4) **Telic Role** (What is it for?) highlights its intended use, social role, or ecological purpose.

This typology allows for a nuanced semantic interpretation of WATER as a cognitively complex and context-dependent concept. Mapping the distribution of these roles across the Directive makes it possible to identify recurrent patterns of the conceptual emphasis and regulatory framing.

(1) Formal Role (What kind of thing is it? What is its nature?): The Formal Role defines what WATER is and how it is officially classified. In the Water Framework Directive, this role is mainly expressed through clear definitions that describe WATER as a hydrological, ecological, or legal object. These definitions place WATER within the scientific and legal taxonomic architecture of the EU water policy. For example, "groundwater" is defined as "all water which is below the surface of the ground in the saturation zone and in direct contact with the ground or subsoil" (European Parliament and the Council, 2000, Art. 2(2)), while "surface water" means "inland waters, except groundwater; transitional waters and coastal waters..." (European Parliament and the Council, 2000, Art. 2(1)). Other definitions include "body of surface water", which refers to "a discrete and significant element of surface water such as a lake, a reservoir, a stream, river or canal…" (European Parliament and the Council, 2000, Art. 2(10)), and "artificial water body", described as "a body of surface water created by human activity" (European Parliament and the Council, 2000, Art. 2(8)).

These definitions are not merely technical. They standardise how WATER is treated legally and administratively across the EU and establish the foundational categories for monitoring, assessment and regulatory action. In cognitive terms, the Formal Role stabilises the conceptual identity of WATER, ensuring interpretative consistency across legal, ecological, and hydrological domains.

(2) Constitutive Role (What is it made of? What are its constituents?): The Constitutive Role focuses on what WATER is made of and how its quality is described. In the WFD, this includes aspects such as pollution, chemical and ecological status, and general water quality. For example, the Directive states that "good water quality will contribute to securing the drinking water supply for the population" (European Parliament and the Council, 2000, Recital 24) and highlights the need to "reduce pollution of groundwater" (European Parliament and the Council, 2000, Art. 4(1)(b)(iii)). One definition explains: surface water status "is the general expression of the status of a body of surface water, determined by the poorer of its ecological status and its chemical status" (European Parliament and the Council, 2000, Art. 2(17)). These formulations demonstrate that WATER is conceptualised not only through legal categorisation but also through scientifically measurable attributes. The key elements include its pollution levels, chemical safety, and ecological health. Technical indicators, for example, environmental quality standards, defined as "the concentration of a particular pollutant or group of pollutants in water, sediment or biota which should not be exceeded" (European Parliament and the Council, 2000, Art. 2(35)). are part of this role. The concept of "good groundwater status" combines both quantity and chemical quality as required standards. To support this, the WFD introduces detailed monitoring programmes "to establish a coherent and comprehensive overview of water status" (European Parliament and the Council, 2000, Art. 8(1)).

Together, the Constitutive Role frames WATER as a measurable, controllable substance whose internal properties directly inform regulatory decision-making.

(3) Agentive Role (How did it come into being? What brought it about?): The Agentive Role deals with the causes and processes that affect WATER. In the WFD, this includes both natural factors and human actions that change WATER's condition, quality, or amount. Examples such as "pollution from discharge", "abstraction", "recharge", and "natural replenishment" show how WATER is changed, damaged, or restored. The Directive also calls for a "progressive reduction of pollution of groundwater" (European Parliament and the Council, 2000, Art. 1(d)) and actions to "cease or phase out discharges, emissions and losses of priority hazardous substances" (European Parliament and the Council, 2000, Art. 1). Another important goal is to "ensure a balance between abstraction and recharge of groundwater" (European Parliament and the Council, 2000, Art. 4(1)(b)(ii)).

This role also refers to broader environmental and social effects, including events such as "floods and droughts" and changes made to the physical characteristics of a surface water body "for reasons of overriding public interest" (European Parliament and the Council, 2000, Recital 32). The Directive also links this role to policy-making, for example by stating that "Community water policy should be based on a combined approach using control of pollution at source" (European Parliament and the Council, 2000, Recital 40), and requiring measures "to prevent or reduce the impact of incidents in which water is accidentally polluted" (European Parliament and the Council, 2000, Recital 39).

Overall, the Agentive Role presents WATER as a dynamic entity shaped by interacting natural and institutional forces, rather than as a purely static resource.

(4) Telic Role (What is it for? How does it function?): The Telic Role refers to the purposes and practical uses of WATER. In the Directive, WATER is described as a resource used for drinking, farming, industry, energy, and the protection of ecosystems. Expressions "drinking-water supply", "power generation", and "irrigation" highlight how WATER supports both human life and nature. The document links the water use to environmental goals, such as the need to protect and enhance "the status of aquatic ecosystems and, with regard to their water needs, terrestrial ecosystems and wetlands" (European Parliament and the Council, 2000, Art. 1(a)).

This role appears in planning and water management. The idea of "sustainable use of water" supports long-term planning, including "forecasts of supply and demand for water in the river basin district" (European Parliament and the Council, 2000, Annex III(a)). WATER is treated as an economic resource, with the Directive encouraging "water-pricing policies [that] provide adequate incentives for users to use water resources efficiently" (European Parliament and the Council, 2000, Art. 9(1)).

The Telic Role thus frames WATER as both a functional and strategic resource, embedded in planning, pricing, and sustainability-oriented governance mechanisms.

These four Qualia roles together provide a structured framework for analysing how the WATER concept is constructed in the Water Framework Directive. The Formal Role stabilises WATER's legal and hydrological identity, the Constitutive Role foregrounds its measurable internal properties, the Agentive Role captures processes of change and impact,

and the Telic Role reflects functional and socio-economic purposes. Their combined yet uneven activation lays the groundwork for the quantitative analysis that follows.

2.2 Role frequency analysis of the WATER concept

To support this analysis, a frequency-based count of the WATER concept was carried out. Each occurrence was tagged and grouped according to its Qualia role. This procedure makes it possible to assess not only the presence of the particular roles, but also their relative conceptual weight within the Directive.

Across the full text of the Water Framework Directive, the WATER concept appears in approximately 446 tagged instances. These occurrences were classified as follows: Formal Role – 145 mentions (32.5%), Constitutive Role – 139 mentions (31.2%), Agentive Role – 86 mentions (19.3%), and Telic Role – 76 mentions (17.0%).

Table 1. Frequency of the WATER Concept by Qualia Roles

Qualia Role	Frequency	Percentage of Total Mentions
Formal	145	32.5%
Constitutive	139	31.2%
Agentive	86	19.3%
Telic	76	17.0%
Total Tagged Mentions	**446**	**100%**

The Formal Role is the most frequent in the Directive, accounting for 145 of 446 occurrences (32.5%). This indicates that WATER is predominantly conceptualised as a clearly defined legal and ecological category, as reflected in recurrent terms such as “groundwater”, “surface water”, and “water body”. Such prominence aligns with the Directive’s regulatory objective of precise classification, which provides a stable foundation for monitoring, compliance, and policy implementation.

The Constitutive Role appears almost as frequently, with 139 mentions (31.2%). This high number shows the importance placed on WATER’s internal features, especially its chemical and ecological conditions, levels of pollution, and other measurable indicators. Frequent expressions such as “good status”, “contamination”, and “chemical composition” demonstrate that WATER is framed not only as a legal object but also as a scientifically assessable resource. Together, these patterns underscore the Directive’s reliance on quantification and standardised assessment.

Together, the high frequencies of the Formal and Constitutive roles show that the Directive conceptualises WATER primarily through taxonomic precision and measurable internal attributes. This distribution reflects the logic of EU environmental governance discourse, which depends on stable categories and standardised indicators to enable regulatory control and comparability across the Member States.

The Agentive Role is found in 86 cases (19.3%). Although less common than the first two roles, it still points to a strong conceptual focus on the causes and processes that affect

WATER. These include human actions such as "discharge", "abstraction", or "artificial modification". Its comparatively lower frequency suggests that causative processes are acknowledged mainly insofar as they need to be identified, regulated, or mitigated.

The Telic Role is the least frequent, with 76 mentions (17.0%), but it remains conceptually important. This role highlights the practical and social uses of WATER, such as "drinking-water supply", "irrigation", "power generation", and "ecosystem sustainability". These references link water governance to broader societal and sustainability objectives, even though they are not the primary focus of the Directive.

The relatively low frequencies of the Agentive and Telic roles indicate that causal processes and functional purposes are recognised but remain secondary within the Directive's conceptual architecture. These roles are activated primarily to justify regulation or identify pressures, rather than to model WATER as an active ecological or economic agent. As a result, the WATER concept is framed predominantly as a classified and measurable entity, revealing a marked conceptual asymmetry shaped by institutional priorities.

It is also important to note that many occurrences display Qualia overlap, in which a single use of *water* activates several roles simultaneously. Each instance (including plural *waters*) was analysed at the sentence level and tagged for all relevant roles. For example, "groundwater abstraction for drinking purposes" combines Agentive and Telic dimensions, while "polluted surface water bodies" involves Formal, Constitutive, and Agentive aspects. Such co-activation demonstrates that the WATER concept in the Directive is not fragmented but integrative, capable of encoding classification, composition, causation, and purpose within a single expression.

This integrated structure reflects the ideas of the Generative Lexicon (Pustejovsky, 1995), which argues that lexical items in specialised discourse carry layered and dynamic meanings that are activated contextually. In the case of the Water Framework Directive, this means that WATER functions simultaneously as a definitional anchor, a monitored substance, a regulated process, and a policy justification, serving both semantic and governance-related functions.

2.3 Statistical validation of the WATER concept (via Chi-Square test)

To assess whether the observed distribution of Qualia roles in the Directive departs significantly from a uniform baseline, a chi-square goodness-of-fit test was applied as an exploratory statistical tool. The test compares the observed frequencies of Qualia roles with expected frequencies calculated under an assumption of equal distribution across all four roles. Under this abstract reference model, each role would be expected to occur approximately 111.5 times (446 total occurrences divided by four).

The purpose of applying this test is not to claim that Qualia roles should be evenly distributed in legal texts, but to quantify the degree and direction of deviation from a neutral semantic baseline. Such baselines are commonly employed in corpus-based semantic research to assess conceptual skew, even when equal distribution is not theoretically anticipated.

Table 2. Chi-Square Test for Qualia Role Distribution

Qualia Role	Observed	Expected
Formal	145	111.5
Constitutive	139	111.5
Agentive	86	111.5
Telic	76	111.5

The chi-square test yielded χ^2 (3) = 33.98, p < .001, indicating a statistically significant divergence between the observed and expected frequencies of the four Qualia roles. The extremely low p-value (≈ 0.0000002) confirms that the distribution is highly non-uniform, demonstrating that certain conceptual dimensions are systematically foregrounded, while others are comparatively marginalised.

To clarify, χ^2 measures the overall divergence between observed and expected frequencies, while the degrees of freedom (3) correspond to the number of roles minus one. Since **p < .001**, the null hypothesis of equal distribution is rejected. However, this rejection is interpreted here as an index of conceptual asymmetry rather than as evidence against a linguistically realistic expectation.

Within this framework, the chi-square test does not evaluate the plausibility of equal representation in EU regulatory environmental discourse. Instead, it provides a standardised quantitative metric for assessing how strongly the Directive departs from a hypothetical semantic equilibrium. This allows the study to operationalise the concept of conceptual imbalance and relate it to institutional and regulatory constraints shaping the eco-economic conceptualisation of WATER.

The results confirm that the Formal and Constitutive roles are significantly overrepresented, whereas the Agentive and Telic roles occur far less frequently. This pattern corroborates the qualitative findings, showing that the Directive prioritises definitional stability and measurable properties (e.g., "surface water", "chemical status") over causal processes or functional purposes (e.g., "pollution", "drinking-water supply").

Such a distribution reflects the regulatory logic of the Directive itself. As a legal instrument designed to ensure harmonisation, monitoring, and compliance, it relies on precise classification and standardised indicators. Accordingly, the application of the chi-square test is methodologically appropriate, not as a test of linguistic expectation, but as a tool for quantifying the strength of institutional conceptual profiling.

3. Analysis and discussion of findings

The findings of this study provide empirical support for the working hypothesis, demonstrating that the WATER concept in the Water Framework Directive is primarily structured through legal definitions and scientific measurement standards, while its causal, dynamic, and functional aspects receive considerably less textual attention.

The distribution of lexical items across the four Qualia roles reveals a systematic imbalance in conceptual representation. The Formal and Constitutive roles together account

for over 63% of all occurrences, indicating that the Directive prioritises the definition, classification, and regulation of WATER in a stable and standardised manner. By contrast, the Agentive and Telic roles, which encode causation and use, appear markedly less frequently, signalling their secondary status within the Directive's regulatory perspective.

Importantly, the predominance of the Formal and Constitutive roles requires interpretation beyond numerical confirmation. Within the Generative Lexicon framework, this pattern reflects a selective narrowing of the WATER concept toward classificatory identity and measurable internal attributes. Such profiling aligns with the epistemic logic of the EU regulatory environmental discourse, which privileges terminological stability, standardisation, and cross-member-state comparability. From a cognitive-linguistic perspective, the Directive foregrounds those Qualia dimensions that support definitional precision and quantification, while backgrounding roles associated with dynamism, causality, and socio-functional purpose. As a result, WATER is conceptualised primarily as a regulated ecological category rather than as an evolving natural resource embedded in broader socio-economic processes.

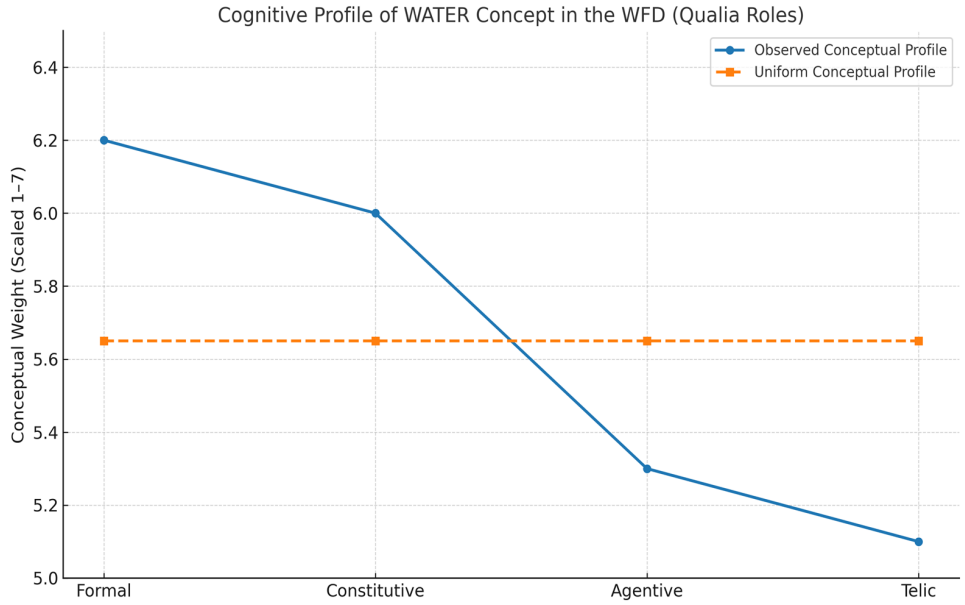

Fig. 1. Cognitive Profile of the WATER Concept in the Water Framework Directive.

At the same time, this conceptual asymmetry must be situated within genre-specific constraints. EU regulatory documents structurally favour stable categories and measurable indicators, meaning that conceptual profiling cannot be interpreted independently of institutional conditions. In line with existing scholarship on environmental governance, the findings confirm that EU regulatory texts tend to encode natural resources through technocratic and status-oriented lexical patterns, rather than through ecologically or

socially dynamic framings. The implications of this tendency are significant: the Directive's conceptual framing reinforces a governance model centred on monitoring, classification, and compliance, thereby limiting discursive space for functional, ecological, or socio-economic perspectives on WATER. Consequently, the cognitive profile of WATER both reflects and reproduces the institutional rationality underlying the EU water policy.

This imbalance is illustrated in Figure 1, which contrasts the observed cognitive profile of the WATER concept with a hypothetical uniform profile in which all four Qualia roles are equally weighted. The sharp decline from the dominant Formal and Constitutive roles to the less prominent Agentive and Telic roles visually captures the Directive's conceptual asymmetry. Such a pattern is characteristic of institutional and regulatory texts, which prioritise semantic stability and control over processuality, change, or use.

As shown in the diagram, the strong emphasis on the Formal and Constitutive roles confirms that the Directive focuses on defining, classifying, and evaluating WATER through stable legal and scientific parameters. In contrast, the reduced presence of the Agentive and Telic roles indicates that WATER's origins and uses are not among the Directive's primary conceptual concerns. These findings fully support the working hypothesis, demonstrating that EU water policy selectively foregrounds measurable and classificatory dimensions of WATER while marginalising more dynamic conceptualisations.

Finally, the consistency with which the WATER concept is encoded throughout the Directive points to a high degree of semantic stability. Such stability is characteristic of the EU environmental governance discourse, as it facilitates policy coordination among Member States and supports the Directive's overarching aim of unified, harmonised environmental regulation.

Conclusion

This study has modelled the eco-economic WATER concept in the Water Framework Directive through a combined Qualia-based and frame-oriented approach, supported by quantitative validation. The findings demonstrate a clear predominance of the Formal and Constitutive roles, indicating that the Directive conceptualises WATER primarily through definitional precision and measurable internal attributes, while Agentive and Telic dimensions are activated far less frequently. This confirms that causal and functional perspectives occupy a secondary position within the Directive's regulatory logic.

This conceptual asymmetry reflects the epistemic and institutional rationality of the EU water governance, which prioritises stability, standardisation, and cross-member-state comparability. As a consequence, the Directive foregrounds WATER as a regulated ecological category, while backgrounding more dynamic socio-ecological processes and functional uses. Such profiling reinforces a governance model centred on classification, monitoring, and compliance, thereby constraining the discursive space available for alternative ecological or socio-economic framings of WATER.

From a methodological perspective, the study demonstrates the analytical value of Qualia-based modelling for uncovering institutional rationalities embedded in

environmental policy texts. At the same time, it acknowledges that the salience of particular conceptual roles is partly shaped by genre-specific conventions of legal drafting, which must be taken into account when interpreting quantitative patterns.

Future research should extend this modelling framework to other EU water and climate policy instruments adopted over the past 25 years, including the European Water Resilience Strategy, in order to trace how the conceptualisation of WATER evolves in response to emerging ecological challenges, climate adaptation imperatives, and increasing governance integration.

Author contributions

Nataliia Kovalyk: conceptualisation, methodology, formal analysis, investigation, writing – original draft, review and editing, visualisation.

Lesia Tymochko: methodology, formal analysis, investigation, writing – original draft, review and editing, visualisation.

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