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ARTICLE

Risk Governance in EU Wastewater Reuse Law

Sophie Melchers

Centre for Water, Oceans and Sustainability Law, Utrecht University, Utrecht, Netherlands
Email: s.a.melchers@uu.nl

Abstract

Increasing water scarcity forced the European Union to investigate the possibility of supplementing natural water sources with reclaimed wastewater. Regulation (EU) 2020/741 sets minimum requirements for the safe reuse of treated urban wastewater in agricultural irrigation. The risks that wastewater reuse presents are further regulated in the numerous EU law instruments that concern the protection of human health, the environment and the European waters, including both laws and principles. This paper applies the widely applicable framework for risk governance that was developed by the International Risk Governance Council to the EU regulatory framework on wastewater reuse. The analysis identifies regulatory gaps – unclear pollutant regulation, incomplete division of responsibilities, and insufficient attention to the science-policy interface – and concrete means of improving the regulation of risks associated with wastewater reuse.

Keywords: Regulation 2020/741; risk governance; wastewater reuse

I. Introduction

Given the increasing prevalence of droughts and the persistent scarcity of water across the European continent, it is a matter of urgency that measures are taken to reduce the risks of water scarcity. As recent as June 2025, the European Commission reiterated this need, detailing that Member States should, in order of priority, reduce consumption, increase water efficiency, reuse wastewater, and increase supplies.[1] As to wastewater reuse, a key point for its regulation is ensuring that wastewater reuse processes are safe for humans, animals and the environment. Hence, there exist a plethora of risk mitigation measures, notably related to the quality the reclaimed wastewater must have prior to its use, created by institutions such as the World Health Organization as early as 2006.[2] At the national level, numerous EU and non-EU Member States have legislated wastewater reuse processes and its safety measures, with varied success.[3] At the EU level, Regulation 2020/741 on minimum requirements for water reuse (the Water Reuse Regulation) aims to harmonise

[1] European Commission, Recommendation on guiding principles of water efficiency first (04 June 2025).

[2] World Health Organization, "Guidelines for the safe use of wastewater, excreta and greywater – Volume 1 Policy and regulatory aspects" (2013).

[3] A Berti Suman et al., "The Advent of EU Water Reuse Regulation in the Mediterranean Region: Policy and Legislative Adaptation to Address Non-Conventional Water Resources Utilization in Agriculture" (2023) 48(7) Water International 839; S Melchers, "European Approaches to Wastewater Reuse Regulation: A Comparison between Spain, Malta and the Netherlands" (2024) 33(3) Review of European, Comparative & International Environmental Law 350.

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wastewater reuse for agricultural irrigation and minimise the associated risks, including through the creation and implementation of Risk Management Plans (RMPs) which are inspired by WHO guidelines and safety plans.[4] This having been said, the EU legal framework for the risks of wastewater reuse extends far beyond the Regulation and includes the ever-evolving Water Framework Directive (WFD), Environmental Quality Standards Directive (EQSD), Urban Waste Water Treatment Directive (UWWTD), Industrial Emissions Directive (IED) when reuse involves industries, and the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) Regulation. The outer boundaries of the risk-regulatory framework are demarcated by the principles of EU environmental law; the precaution, prevention, polluter pays and rectification at the source principles.

Given the highly fragmentary nature of the body of law applicable to wastewater reuse in the EU, the high costs of wastewater reuse, the availability of other water sources and the uncertain consequences of failure to meet environmental targets, it should come as no surprise if Member States choose to not engage in direct wastewater reuse for agricultural irrigation. The Regulation can be sidelined easily in practice: one can simply discharge treated wastewater into a stream or river, in line with requirements of the UWWTD, and then a farmer can use this (surface) water to irrigate their land downstream. This indirect reuse is the norm at the moment in many EU Member States, who have regulated the discharge of wastewater and the uptake of irrigation water accordingly in their national legislation. It is understandable, therefore, that the virtues of direct water reuse do not weigh up against the costs of navigating the regulatory maze of direct wastewater reuse. This paper aims to provide some clarity to help with the realisation of the Regulation and direct wastewater reuse in practice.

The question that underlies this paper is whether the abovementioned EU regulatory instruments, separately or combined, are effective at governing risks associated with wastewater reuse. Section II outlines the methodology used, the theoretical elements of risk governance as created by the IRGC, and how risk governance necessitates a legal framework. Section III describes how risks are governed under the Water Reuse Regulation, evaluating it against the IRGC framework, and the governance of risk in the general legal instruments that govern wastewater reuse together with the principles of EU environmental law. Section IV concludes.

II. The IRGC risk governance framework

To assess the effectiveness of risk regulation that balances the advantages of the reuse of treated wastewater with the environmental and public health risks, we need a robust and comprehensive theoretical underpinning. The governance of risk for water-related issues has been conceptualised by many different institutions and scholars, at many different points in time, and for many different water-related issues.[5] Arguably the broadest risk governance framework is the International Risk Governance Council's Risk Governance Framework, developed in 2005 and updated in 2017. The IRGC framework is a multi-stage

[4] World Health Organization, "Guidelines for the safe use of wastewater, excreta and greywater – Volume 1 Policy and regulatory aspects" (2013).

[5] See, among others, World Health Organisation, "Water Quality: Guidelines, standards and health – Assessment of risk and risk management for water-related infectious diseases" (2001); C Larrue, D L T Hegger and J-B Trémorin, "*Researching flood risk governance in Europe: a framework and methodology for assessing flood risk governance*" (STAR-FLOOD Deliverable 2.2.1, 2013); D L T Hegger, P P J Driessen and M H N Bakker (eds), *A view on more resilient flood risk governance: key conclusions of the STAR-FLOOD project* (STAR-FLOOD Deliverable 6.4, 2016); J Koehler, "Not All Risks are Equal: A Risk Governance Framework for Assessing the Water SDG" (2023) 23 International Environmental Agreements 179; H A C Runhaar et al., "Prepared for Climate Change? A Method for the Ex-Ante Assessment of Formal Responsibilities for Climate Adaptation in Specific Sectors" (2016) 16 Regional Environmental Change 1389.

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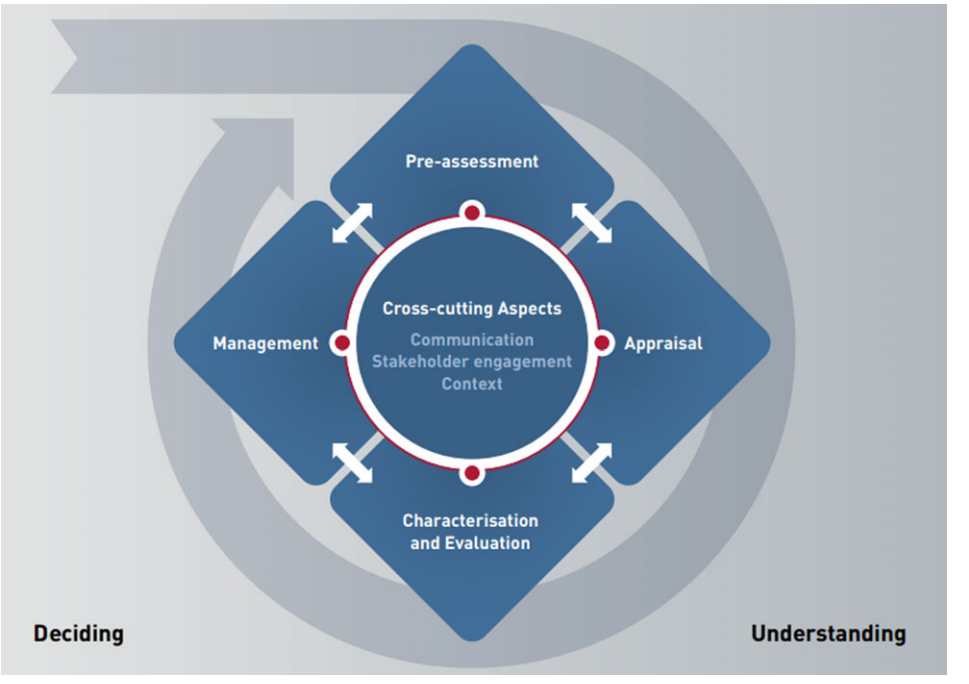


Figure 1. Simplified version of the international risk governance council's risk governance framework. Taken from IRGC. (2017). Introduction to the IRGC Risk Governance Framework. Lausanne: EPFL International Risk Governance Center.

model for understanding how societies can anticipate, evaluate and respond to risks, particularly when uncertainty, ambiguity, and systemic complexity are present (see Figure 1).[6] This framework has been successfully applied to judge the effectiveness of topics ranging from drinking water quality policies[7] to arctic shipping.[8] Given the breadth of the IRGC framework and its successful application to uncertain, ambiguous, and complex risks, this framework was preferred over others. In this article, the IRGC framework is used as a tool to measure the effectiveness of the EU regulation of risks associated with wastewater reuse. This analysis highlights gaps and unclarities that would need to be addressed in order to ensure effective risk governance. The remainder of this section gives a brief conceptualisation of risk governance under the IRGC framework, paying particular attention to the ways in which law structures risk-governance practices.

Developed to go beyond simple, unidirectional risk assessment and management, the IRGC framework is especially useful for analysing risks which lie at the crossroads of the natural system, socio-economic and technological developments, and political decision-making.[9] The governance of risk under the IRGC framework unfolds in four phases: pre-assessment, risk appraisal, risk characterisation and evaluation, and risk management.

[6] International Risk Governance Council, *Risk governance – Towards an integrative approach* (2005).

[7] J Hartmann et al., "Risk Governance of Potential Emerging Risks to Drinking Water Quality: Analysing Current Practice" (2018) 84 Environmental Science and Policy 97.

[8] F Goerlandt and R Pelot, "An Exploratory Application of the International Risk Governance Council's Risk Governance Framework to Shipping Risks in the Canadian Arctic" in A Chircop et al., (eds), *Governance of Arctic Shipping – Rethinking Risk, Human Impacts and Regulation* (Springer 2020).

[9] Supra 6, 19.

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The processes of risk communication and stakeholder involvement cut across each phase.[10] A 2017 revision of the model synthesised the focal points of each phase and yielded checklists for decision-makers.[11] It also argued that the broader social, economic, political, and institutional context as well as risk culture and degree of institutional trust deserve recognition and inclusion in the decision-making.[12]

First, pre-assessment involves the initial framing of the risk, early warning, risk screening, and the identification of the applicable legal framework. Also in this stage rests the identification of the relevant actors their rights, obligations, and interests since it is they who frame the risk and who can identify opportunities to address them. This phase serves to define what is at stake, which is often linked to a legally prescribed goal, such as environmental protection or the safety of drinking water supplies.[13]

Second, risk appraisal blends scientific risk assessment with concern assessment where stakeholders' opinions about risks are collected. Scientific risk assessment entails analyses of the likelihood and consequences of harm, while concern assessment gauges societal perceptions and the socio-economic costs of the relevant risks.[14] In wastewater reuse, pollutant concentrations, exposure pathways, equipment vulnerabilities, public attitudes to reclaimed water and the product which it irrigates, and the economic costs of wastewater reuse all matter. The law mediates the relationship between scientific knowledge and decision-making by using science-based maximally acceptable values (MAVs) as the cut-off between legitimate and illegitimate wastewater reuse and by deferring to scientific knowledge and thus scientific actors for the assessment of local risks. Therefore, the successful execution of the law – in this case, the safe reuse of wastewater – depends heavily on the success of the science-policy relationship: scientific knowledge is the foundation for safe and effective policy measures.

Third, risk characterisation and evaluation involve determining whether a risk is acceptable, tolerable if mitigatory measures are taken, or intolerable. This stage of the process is deeply normative because it depends on value judgments about the permissibility of risks; the risks of inaction should also be taken into account.[15] Again, the law here plays a key role: what is "acceptable" can be set in law in the form of limit values such as MAVs of pollutants in wastewater. If the risk appraisal shows that these limits are exceeded, the law may demand action. Moreover, the processes of what is deemed "acceptable" if it is not or cannot be expressed in numbers will be based on legally embedded principles such as fairness and proportionality. Equally important in this process is the requirement of due process, involving the need to review evidence, making non-arbitrary decisions, and transparent or at least open decision-making processes.

Fourth, risk management is the phase during which regulatory and policy decisions are made, implemented, and reviewed. The law therefore plays a critical role here. The important questions to be answered here revolve around the obligations of each involved actor, the selection of available measures, and the trade-offs.[16] Equally important are enforcement and recourse to legal remedies after risk-management measures have been put into place. The obligations of actors are laid down, at least to a large degree, in EU and national administrative laws. The measures between which the regulator chooses may be legal instruments such as binding standards, permitting systems and enforcement mechanisms. In wastewater reuse, several non-legal risk-management measures are also

[10] *Supra* 6, figure 5 on p. 65 and pp. 23–48.

[11] International Risk Governance Council, *Introduction to the ICRG risk governance framework – Revised version 2017* (2017).

[12] Ibid, 32.

[13] *Supra*, 6, 24.

[14] *Supra*, 6, 34–6.

[15] *Supra*, 11, 23–6.

[16] *Supra*, 6, 36–40.

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conceivable. For example, there may be limitations on the pollutants that may be present in the reclaimed wastewater and their concentration. The choice of instrument is also informed by other legal framework: for example, the chosen measures cannot breach the human right to access to water or discriminate unlawfully. This is the safeguarding function of the law. It guarantees that risk governance is fair and just, and that damage can be remedied *ex post*.[17] Lastly, whatever risk management measure is chosen and implemented, enforcement and (the threat of) penalties help ensure its actualisation.

Risk communication, which features in all four of the phases of the IRGC framework that were described above, is a prerequisite for transparency, active stakeholder engagement in all phases, and the exchange of knowledge between scientists, lawmakers and policymakers, operators, and the public. It is essential for building trust and for ensuring the legitimacy of the governance process. The law here can promote risk communication by mandating the involvement of the public in decision-making and regular communication of policy decisions.[18]

In summary, risk governance is a cycle of risk assessment and management in which law is not merely a tool for implementing risk-management policies but a framework that focusses, enables, constrains, and legitimises risk governance itself. It organises institutional roles, embeds democratic values into decision-making, it ensures compliance through enforcement, and it facilitates the integration of science and societal values. The functions in question underscore the need for legal designs that are both technically sound and normatively robust. This point is particularly true for the regulation of wastewater reuse where risks are complex, uncertain and socially sensitive. While ambitious, the IRGC framework could be implemented in its detailed entirety. Hence, existing risk governance, be it for wastewater reuse or another risky behaviour, can be evaluated against the IRGC framework to find good practices, gap or ambiguities.

III. The regulation of risks associated with wastewater reuse in EU law

Having sketched out the contours of the IRGC framework, one must now turn to the body of law that will be evaluated in light of this framework. The legal framework for assessing and managing risks that are associated with wastewater reuse is laid down across three layers of EU law. At the most concrete level, there is the Wastewater Reuse Regulation, which entered into force in July 2023.[19] This Regulation governs the use of urban wastewater for agricultural irrigation. It sets minimum water-quality standards and monitoring frequencies, and it stimulates the management of more context-dependent risks through local Risk Management Plans. Some EU Member States have regulations on wastewater reuse that precede the Regulation, other Member States have implemented the Regulation once it became applicable on 26 June 2023.[20] The intermediate regulatory layer consists of EU laws of broader application such as the WFD, the UWWTD, the EQSD, the IED, and the Groundwater Directive. Parts of the Drinking Water Directive and the Nitrates Directive may also be applicable. Finally, at the third and most general level, there are the four main principles of EU environmental law: the precautionary principle, the principle of prevention, the polluter-pays principle, and the rectification-at-the-source

[17] H K Gilissen et al., "Towards More Effective Environmental Risk Regulation: An Analysis of Complementary Effects between Administrative Environmental Law and Tort Law in the Regulation of Environmental Risks, with a Specific Focus on Chemical Mining Activities in the Deep Subsoil" (2021) 18(1) JEEPL 77, 84.

[18] See, for example, the obligations laid down in Arts. 9 and 10 of the Water Reuse Regulation.

[19] Council Regulation (EU) 2020/741 on Minimum Requirements for Water Reuse [2020] OJ L 177/32 [hereafter: Water Reuse Regulation].

[20] S Melchers, "European Approaches to Wastewater Reuse Regulation: A Comparison between Spain, Malta and the Netherlands" (2024) 33(3) Review of European, Comparative & International Environmental Law 350.

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principle. Since the Regulation is the most concrete of the three layers, only the Regulation will be explicitly evaluated against the IRGC framework. Once regulatory gaps and normative tensions are identified based on this evaluation, the broader regulatory framework and the EU environmental principles will be analysed to see whether they cover these gaps, resolve the normative tensions, and bring the risk regulation of wastewater reuse in the EU closer to the theoretical ideal.

1. The first layer of risk governance: the Water Reuse Regulation

It is important to begin by noting that wastewater reuse is one of many measures that can address the risk of droughts and water stress in Europe. Water resilience measures such as desalination or managed aquifer recharge might be implemented in conjunction with reuse or even preferred over it. These measures, which increase supply, have to be considered only after measures which reduce demand have been exhausted following the EU's water hierarchy[21] or the more recent "water efficiency first" principle.[22] The position of wastewater reuse in this hierarchy was, at first, unclear. Whether wastewater reuse was deemed to reduce demand or to increase supply, as it depends on whether one believes that it aims to reduce pressures on surface and groundwater or make more water available for, for example, agricultural or industrial processes. Then, the Water Reuse Regulation alluded that wastewater reuse should be characterised as a supply-increasing measure.[23] The recent Water Resilience Strategy takes a different and more decisive stance: wastewater reuse is somewhere in the middle: wastewater reuse can only be considered after demand-reducing measures have been exhausted, but before supply-increasing measures are taken.[24] Either way, the risks that are associated with wastewater reuse and the risk-management measures available should be examined – only then can one judge whether it is a practice one wants to engage in.

There are many risks associated with wastewater reuse because it involves a very wide array of human and natural systems. These risks pertain predominantly to the quality of the reclaimed wastewater, although incidents during treatment, transport, and application can also harm humans and the natural system.[25] The reuse of wastewater for agricultural purposes poses direct threats to farmers, workers and local communities, as well as to crops, the soil, groundwater and surface waters.[26] The animals and consumers who consume crops may also be at risk. The water quality that needs to be achieved for these threats to be addressed depends on whether and how humans and ecosystems are affected by wastewater reuse. One example, while not practised much in the EU, is the production of drinking water from wastewater: human-health risks arise from the pathogens and organic compounds that are present in (partially treated) wastewater, which include endocrine disruptors and pharmaceuticals.[27] As for agricultural irrigation, the water-

[21] European Commission. (2007). "Communication Addressing the challenge of water scarcity and droughts in the European Union". COM(2007) 414 final; European Commission. (2012). A Blueprint to Safeguard Europe's Water Resources. (2012) COM(2012) 673 final; European Commission. (2014). Guidelines on Integrating Water Reuse into Water Planning and Management in the Context of the WFD. Common implementation strategy for the Water Framework Directive and the Floods Directive.

[22] European Commission, "European Water Resilience Strategy" (Communication) COM/2025/280 final [hereafter: Water Resilience Strategy], 7; European Commission, Recommendation on guiding principles of water efficiency first (04 June 2025); European Commission, Annex to the Recommendation on guiding principles of water efficiency first.

[23] Water Reuse Regulation, recitals 3, 4 and 5.

[24] Water Resilience Strategy, 7.

[25] R Maffettone and B M Gawlik, Technical Guidance - Water Reuse Risk Management for Agricultural Irrigation Schemes in Europe, Publications Office of the European Union, Luxembourg, 2022, doi:10.2760/590804, JRC129596, 6.

[26] Ibid.

[27] N Voulvoulis, "Water Reuse from a Circular Economy Perspective and Potential Risks from an Unregulated Approach" (2018) 2 Current Opinion in Environmental Science & Health 32, 35–6.

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quality risks vary across irrigation methods and with the post-harvest treatment of the crops.[28] The use of irrigation methods such as drip or spray irrigation also determines the extent to which the reclaimed wastewater will impact groundwater.[29] Spray irrigation may also affect human health because labourers or passers-by may come into contact with the water and because the reclaimed wastewater would then cover a larger part of the crops.[30]

Given the risks that are associated with using partially treated wastewater, one may argue that it is safer to treat all wastewater to achieve drinking-water quality – all possible mishaps would thus be avoided. Adding any necessary compounds, such as nutrients for crop irrigation, can be done in a controlled manner afterwards. However, universal water-quality standards would have to be as strict as possible, which would make compliance inordinately expensive.[31] Moreover, those standards might reduce the perceived risks, but they would not necessarily prevent irrigation from being cast as the cause of produce-related diseases in public discourse.[32] Lastly, when scientific insights on new contaminants and their effects reveal new risks, even the strictest water-quality standards would have to be updated. Therefore, the Water Reuse Regulation seeks to ensure that those who participate in water-reuse projects create RMPs that provide for thorough risk assessment and risk management to ensure safe reuse of wastewater.

a. Risk management plans

Under the Water Reuse Regulation, risks to human health and natural systems are minimised through two pathways: the provisions of the Regulation itself and the mandatory RMP. The former are directly applicable to all EU Member States by definition and the RMP allows local contexts to influence the assessment and management of risk. A 2022 Commission Notice and a 2024 delegated Regulation provide Member States and water-reuse actors with further information about the application of the Water Reuse Regulation and the components of the RMP, respectively.[33] Similarly, the 2022 Technical Guidance report of the JRC aims to help local actors to create RMPs.[34] This combination of centralised and decentralised system-specific risk management reflects the delicate balance between subsidiarity and harmonisation that the EU regulator must achieve: the Regulation ensures baseline safety and consistency across the EU, while the RMP enables localised risk assessment and management. Slowly but surely, further tools to create local RMPs and the actual RMPs themselves are being produced across the EU.[35] For example, a

[28] M L Partyka and R F Bond, "Wastewater Reuse for Irrigation of Produce: A Review of Research, Regulations, and Risks" (2022) 828 Science of the Total Environment 154385, 6.

[29] D M Narain-Ford, R P Bartholomeus, S C Dekker and A P van Wezel, "Natural Purification Through Soils: Risks and Opportunities of Sewage Effluent Reuse in Sub-surface Irrigationin" in P de Voogt (ed), Reviews of Environmental Contamination and Toxicology Volume 250 (Springer 2020); X Zhang, R Wang, H Dai, L Wang, L Chen, H Zheng and F Yu, "Simulation of Soil Water Transport and Utilization in an Apple–Soybean Alley Cropping System Under Different Irrigation Methods Based on HYDRUS-2D" (2025) 15(4) Agronomy 993. 3.

[30] D M Revitt, L Lundy and D Fatta-Kassinos, "Development of a Qualitative Approach to Assessing Risks Associated with the Use of Treated Wastewater in Agricultural Irrigation" (2021) 406 Journal of Hazardous Materials 124286.

[31] *Supra* 27, 7.

[32] Ibid; S Toze, "Water Reuse and Health Risks – Real vs. Perceived" (2006) 187 Desalination 41, 42.

[33] European Commission, "Guidelines to support the application of Regulation 2020/741 on minimum requirements for water reuse" (Commission Notice) 2022/C 298/01; European Commission, Delegated Regulation (EU) 2024/1765 of 11 March 2024 supplementing Regulation (EU) 2020/741 of the European Parliament and of the Council with regard to technical specifications of the key elements of risk management.

[34] Supra 24.

[35] See, for example, the Dutch tool for creating a RMP Risicobeheerplan voor een waterhergebruiksysteem | Informatiepunt Leefomgeving, the Sicilian RMP in A Cosenza et al., "Transition to Circular Economy in the Water Sector by Legislative Perspectives for the Sicilian Region (Italy)" in G Mannina, A Cosenza and A Mineo (eds), *Resource Recovery from Wastewater Treatment ICWRR 2024* and the case studies analysed in R Maffettone and B M

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preliminary RMP for the Italian island of Sicily uses semi-quantitative methods to assess human health risks.[36]

The RMP must contain five "key elements," which differ in name and partially in content from the IRGC framework. To clearly analyse the effectiveness of the governance of risks associated with wastewater reuse following the EU legal framework, the next sections follow the four-phase structure of the IRGC.

b. Pre-assessment

The European Union began to call for treated wastewater to be reused wherever and whenever possible as early as 1991.[37] This position was reiterated in the 2001 WFD, where wastewater reuse features as a supplementary measure which Member States may implement to attain the environmental objectives of the Directive.[38] In the text of the Water Reuse Regulation, the potential benefits of wastewater reuse are linked to the broader issue of water stress and to the legally defined goal of environmental protection.[39] The Water Reuse Regulation recognises water stress as a key policy driver and elaborates on the references to reuse in the WFD and UWWTD. The more recent Water Resilience Strategy also refers to wastewater reuse as a potential solution for water stress and ecosystem protection.[40] According to the text of the Regulation, the Member State's decision to engage in wastewater reuse for agricultural irrigation depends on whether water stress is a threat to its water resources and on the availability of other more economical solutions.[41] The decision to engage in wastewater reuse is simultaneously part of the WFD's River Basin Management Plans (see below). In light of the Regulation, the decision to engage in wastewater reuse must be reviewed every six years, and the review must account for up-to-date climate-change projections and national climate-adaptation strategies.[42] There are no early-warning or risk-screening obligations *per se* in the texts of the Regulation or its accompanying documents.

Understanding who is involved in the remainder of the risk assessment, in the risk characterisation evaluation and in the risk management is a crucial element of the pre-assessment. Again, some actors who must be involved in the assessment and management of risk are identified in the Regulation, while the Member States are free to supplement that list through their own administrative laws; even at the local level, the parties that create the RMPs can lay down more specific responsibilities for different actors.

The Water Reuse Regulation points at three actors who *must* be involved: the Member State itself as the addressee of the Regulation, reclamation-facility operators who operate or control facilities where wastewater is reclaimed, and "competent authorities."[43] The Member State has three main obligations at the very beginning and the very end of the regulatory process. At the beginning, the Member State must determine whether to allow

Gawlik, "Technical guidance – water reuse risk management for agricultural irrigation schemes in Europe", Publications Office of the European Union, Luxembourg, 2022, doi:10.2760/590804, JRC129596.

[36] A Cosenza et al., "Transition to Circular Economy in the Water Sector by Legislative Perspectives for the Sicilian Region (Italy)" in G Mannina, A Cosenza and A Mineo (eds), *Resource Recovery from Wastewater Treatment ICWRR 2024*.

[37] Council Directive (EU) 91/271/EEC of 21 May 1991 concerning urban waste-water treatment [1991] OJ L 135 [hereafter: UWWTD 1991].

[38] Council Directive (EU) 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy [2000] OJ L 327 [hereafter: Water Framework Directive].

[39] Recital 2.

[40] Water Resilience Strategy, 6.

[41] Water Reuse Regulation, Art. 2(2).

[42] Ibid.

[43] Water Reuse Regulation, Art. 3(6).

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wastewater reuse for agricultural irrigation on its territory. This decision must account for the specificities of the local river-basin districts.[44] When reclaimed wastewater is used for agricultural irrigation, the Member State must inform the public of, among others, the percentage of reclaimed water relative to the total amount of treated urban wastewater and the results from compliance checks, which must also be made available to the EEA and the European Centre for Disease Prevention and Control.[45] Lastly, the Member State must lay down rules on penalisation, and determine who is the "competent authority," which depends on its national administrative structure.[46] This ambiguously defined "competent authority" must ensure that RMPs are in fact created by the relevant reclamation facility operators and it is also in charge of assessing applications and granting permits for the production and supply of reclaimed water.[47] For example, the Dutch government has pointed out the Dutch provinces as "competent authorities" under the Regulation making them the permitting authorities as well.[48] The reclamation-facility operator, be it a private entity or public authority, then assumes control over the implementation of the Water Reuse Regulation on the ground. This person or entity is responsible for the safety of the water-reuse system as operationalised by the water-quality standards, for monitoring, and for the preparation of the RMP, together with other responsible parties "as appropriate."[49] The reclamation-facility operator is, however, responsible for the water quality only up to the "point of compliance": the location of this point and who is then responsible for the water quality – and therefore many of the risks associated with wastewater reuse – is not laid down in the Regulation and must instead be laid down in the wastewater reuse permit.

The RMP should therefore further divide responsibilities between all involved actors.[50] It should also contain additional responsibilities for the reclamation-facility operator and for the other parties that are in charge of the key elements of risk management.[51] The operator of the wastewater reclamation facility must, at a minimum, consult all other relevant parties and end users.[52] The JRC's Technical Guidance identified *inter alia* the operator of the wastewater treatment plant, those responsible for the distribution and storage, and end-users as responsible parties for the identification and management of risks.[53] There appears to be an important but blurred distinction between "stakeholders" and "responsible parties." Only "responsible parties," which are directly involved in the water-reuse system, may participate in the making of the RMP; these are the reclamation facility operator, "other responsible parties" such as distribution or storage operators, and end-users, here most likely the farmers.[54] Stakeholders, conversely, do not take part in its creation, but must nevertheless be identified so that relevant risk-related information may be communicated to them.[55]

Another practical challenge arises, namely how the decision-making process should be organised. An "RMP Team" can be responsible for the development, implementation, and

[44] Water Reuse Regulation, Art. 2(2).
[45] Water Reuse Regulation, Arts, 10 and 11.
[46] Water Reuse Regulation, Art. 15.
[47] Water Reuse Regulation, Art. 5(1) and 6.
[48] Dutch Government, Uitvoeringsbesluit verordening hergebruik stedelijk afvalwater (2023), 14.
[49] Water Reuse Regulation, Arts, 4 and 5(2).
[50] European Commission, Commission Notice Guidelines to support the application of Regulation 2020/741 on minimum requirements for water reuse (2022/C 298/01), 15.
[51] Regulation (EU) 2020/741, Arts,5(2) and 5(4)(c).
[52] Regulation (EU) 2020/741, Art. 5(2).
[53] *Supra* 24, 24–5.
[54] *Supra* 49, 12.
[55] *Supra* 24, 24–5; *Supra* 49, 11 and 15.

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maintenance of the Plan and for communicating with other "participating organizations."[56] However, it remains unclear how that team is to be formed. Even after the line between "responsible party" and "stakeholder" is drawn and an RMP Team is formed, it remains unclear how decisions are to be made about the content of the RMP. For example, is there a requirement of unanimity before a decision can be made, or a right for the public to be consulted?

c. Risk appraisal

The risk-appraisal phase of the IRGC framework emphasises the importance of scientific knowledge and stakeholder opinions for understanding the nature and the context-specific dimensions of risk. The semi-quantitative, quantitative or qualitative assessment covers risks to the environment and to human and animal health.[57] It accounts for the identified hazards, the populations and environments at risk, and exposure routes, as well as for the duration of the intended uses and the severity of the identified hazards.[58] The Regulation stipulates that this risk assessment must be conducted with due regard for the precautionary principle and for all relevant EU and national legislation and guidance documents on food and feed hygiene, animal health, and worker safety.[59] Reference is also made to ISO standards and WHO Guidance Documents.[60]

While the Regulation provides a detailed framework for scientific risk assessment, it pays less attention to the socio-economic concern assessment, which is not a formal requirement of the RMP. Yet, effective management of water-reuse systems also depends on acknowledging non-scientific dimensions of risk governance, including social acceptance, user satisfaction, willingness to pay, and broader economic and reputational implications. These elements are recognised in the JRC's Technical Guidance, which encourages their inclusion even in the absence of binding obligations.[61]

d. Risk characterisation and evaluation

The Water Reuse Regulation reflects some elements of the third stage of the IRGC framework, which covers risk characterisation and evaluation. It operationalises them in a rather technocratic and standardised manner. In the IRGC framework, the third phase involves determining whether a risk is acceptable, tolerable if mitigated, or intolerable, depending on both scientific findings and value-based judgements about what society is willing to accept. The Water Reuse Regulation itself was preceded by extensive consultation with both scientists and other stakeholders.[62] However, the normative dimension of social acceptance is not particularly explicit in its text. The minimum water-quality requirements and monitoring standards set a baseline of "acceptability" across all EU Member States. These uniform thresholds effectively foreclose the possibility of stakeholder input and local value judgements. The RMP then reintroduces local context by enabling Member States and local operators to assess the necessity of additional measures "so that any risks are of an acceptable level."[63] This approach acknowledges that some

[56] *Supra* 24, 25.

[57] Water Reuse Regulation, Annex II (A) under 5, and see, for example, R Maffettone et al., "Water Reuse in the European Union: Risk Management Approach According to the Regulation (EU) 2020/741" in M Minella, A B Prevot and V Maurino (eds), *Water Reuse and Unconventional Water Resources – A Multidisciplinary Perspective*.

[58] Water Reuse Regulation, Annex II (A) under 5.

[59] Ibid.

[60] For example, Water Reuse Regulation, recital 16

[61] *Supra* 24, 57.

[62] European Commission, Proposal for a Regulation on minimum requirements for water reuse, COM(2018) 337 final, 6–10.

[63] Water Reuse Regulation, 6(3)(d).

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risks may be tolerable only if mitigated further, in line with the IRGC concept of "tolerable if mitigated." The responsibility to determine what is "tolerable if mitigated" and what these additional measures should then rest with the earlier identified responsible parties.

e. *Risk management*

The risk-management phase of the IRGC framework focuses on the articulation and implementation of strategies that reduce, control and communicate risk appropriately. The Water Reuse Regulation incorporates several core elements of this phase such as the MAVs for a limited number of pollutants and monitoring frequencies. These measures are combined with the flexible and context-sensitive RMP. Since the number of pollutants regulated under the Regulation is very limited, the MAVs of other pollutants and corresponding monitoring requirements will most likely have to be regulated at the local RMP level. Other risk-management measures may include access limitations; specific rules on irrigation, such as on the distance between a sprinkler and sensitive areas; and limited access for animals to land irrigated with reclaimed wastewater.[64] Water-quality control systems and environmental monitoring systems should also be set up, as should protocols for incidents and emergencies and mechanisms for coordination between the different actors that are involved.[65]

The foregoing means that it is mostly the Member States and the parties which are involved in the water-reuse system which have to bear the burden of assessing and managing the risks that are associated with the numerous pollutants that the EU has not regulated thus far. Each RMP should include minimum water-quality and monitoring requirements for these other pollutants. Which requirements will be included depends on the outcomes from the risk assessments, which vary with local uses and circumstances. This leaves quite some regulatory flexibility to each Member State – which may set nationwide minimum requirements under the guises of environmental protection, food safety, worker safety or any other legislative theme under which the water-reuse system could reasonably be subsumed. Importantly, if Member States do not (yet) have such standards, it is up to the parties which are involved in the hazard assessment and the creation of the RMP to determine which pollutants should be subject to control and what form this control should take. Since this is undoubtedly a highly technical and costly endeavour, cooperation between the parties which are associated with different water reuse systems and RMPs is recommended in the absence of nationwide standards.

f. *Interim conclusion*

While the Water Reuse Regulation is a significant step toward harmonising the safe use of reclaimed water for agricultural irrigation across the EU, using the IRGC framework to analyse EU wastewater reuse law highlights that several regulatory gaps remain. First, the Regulation lays down MAVs and monitoring requirements for very few pollutants. Other pollutants, such as pharmaceuticals, microplastics and antibiotics, must be assessed and managed by national or local actors under different regulatory frameworks – national laws, or EU legal frameworks such as the WFD, the UWWTD, the Groundwater Directive, and the Nitrates Directive or through the environmental principles of EU law, which form the next two subsections.

Second, the Regulation mandates stakeholder participation in the development and implementation of the Risk Management Plan, it refrains from prescribing a uniform model for such involvement. This legislative restraint reflects the subsidiarity principle,

[64] Water Reuse Regulation, Annex II (C) under 7.
[65] Ibid, under 8–11.

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which allows Member States discretion to design administrative mechanisms suited to their institutional and legal traditions. Yet this deference to national autonomy also generates fragmentation and administrative uncertainty, as the European Commission's Joint Research Centre Technical Guidance provides little clarity on how competences should be coordinated across governance levels.

This situation highlights the broader tension between subsidiarity and harmonisation that pervades EU environmental governance.[66] On the one hand, subsidiarity ensures respect for national diversity and fosters local legitimacy; on the other hand, the pursuit of environmental- and public-health protection often requires a degree of harmonisation to guarantee a consistent standard of safety and risk management across the Union. Striking this balance has proven challenging in EU water law in the past, for example with the (revision of) the Drinking Water Directive.[67] In the context of wastewater reuse, a more explicit delineation of administrative responsibilities to counter the opaque division of responsibilities could help enhance the Regulation's effectiveness.[68]

Third, the success of the Regulation is premised on the assumption of constant interchanges between science and policy at the EU level (the Commission can adopt delegated acts in light of new scientific findings), at the Member State level (Member States must take climate-change projections and national climate-adaptation programmes into account to determine whether or not to engage in wastewater reuse in its river basins), and at the water-reuse-system level (scientific and policy stakeholders must be involved in the creation of RMPs). Given the social and scientific complexity of the issues at hand, combined with the multitude of actors involved at multiple governance levels, rollout of wastewater-reuse projects can be expected to be delayed considerably if the science-policy interface is not robust.[69]

2. *The second layer of risk governance: general EU legislation on environmental protection, water quality and chemical safety*

The above-mentioned regulatory gaps are addressed, albeit incompletely, by the broader water-governance framework of the EU into which the Water Reuse Regulation is embedded. Instruments such as the WFD, the UWWTD, and the EQSD, which are covered in this subsection, inform the way the risks of wastewater reuse are governed. This section therefore describes the risk regulation of wastewater reuse, taking the three above-described regulatory gaps as the starting point and highlighting points where the broader regulatory framework comprises elements of the IRGC framework. The same structure will be followed for the discussion of the environmental principles of EU law in Section III.

a. Environmental protection, water quality and risk regulation

The Water Reuse Regulation is based on Article 192 TFEU and thus forms part of the framework of EU environmental law. It must, for this reason, be read in conjunction with the WFD, the EQSD, the (recast) UWWTD, the Groundwater Directive, and parts of the Drinking Water Directive and the Nitrates Directive. The Water Reuse Regulation also

[66] N de Sadeleer, "Principle of Subsidiarity and the EU Environmental Policy" (2012) 9 Journal for European Environmental and Planning Law 63.

[67] A Jordan, "The Politics of Multilevel Environmental Governance: Subsidiarity and Environmental Policy in the European Union" (2000) 32 Environment and Planning A: Economy and Space 1307.

[68] H A C Runhaar et al., "Prepared for Climate Change? A Method for the Ex-Ante Assessment of Formal Responsibilities for Climate Adaptation in Specific Sectors" (2016) 16 Regional Environmental Change 1389.

[69] M Dingemans et al., "Responsible Water Reuse Needs an Interdisciplinary Approach to Balance Risks and Benefits" (2020) 12 Water 1264; A Čavoški, "Science and law in Environmental Law and Policy: The Case of the European Commission" (2020) 9 Transnational Environmental Law 263.

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refers to requirements and obligations in these instruments as goals for which risk assessment should account.[70]

The WFD is the flagship EU legislation on water protection. It contains numerous environmental objectives, including the qualitative protection of surface waters and the qualitative and quantitative protection of groundwaters.[71] Risks are managed through a list of "priority substances," for which MAVs are set through the EQSD.[72] Groundwater quantity is covered in the WFD; groundwater quality is covered partially in the WFD, but mainly in the Groundwater Directive. The WFD is connected to the risk regulation of wastewater reuse in two ways. First, the watchlist mechanism in the WFD and EQSD can aid in the early detection of pollutants relevant to the application of reclaimed wastewater.[73] There are no early-warning or risk-screening obligations per se in the texts of the Regulation or its accompanying documents, but obligations of this kind can be incorporated into RMPs as preventative measures.[74] Importantly, the watchlist mechanism in EU legislation, as it appears in the WFD and the EQSD, functions as a tool for both risk screening and early warning. Substances are placed on the watchlist when there is evidence of potential environmental or health risks, but the evidence is insufficient to justify command-and-control regulation. The Member States are required to monitor these substances in surface waters to gather data on their occurrence, concentration and potential risks. This monitoring identifies emerging pollutants, such as pharmaceuticals, endocrine disruptors or industrial substances before they become widespread threats. In the context of wastewater reuse, particularly under the Water Reuse Regulation, the presence of watchlist substances in reclaimed water can inform the development of site-specific RMPs. The actors who are involved in the water-reuse system and the competent authorities may use watchlist data to assess local hazards and to introduce additional treatment or monitoring where necessary. Thus, the watchlist enables proactive risk identification and supports adaptive management by flagging substances of concern early and by guiding regulatory decisions at the EU level and practical risk management at the local level. It can aid local water operators in preparing RMPs, and it ensures that emerging risks are not overlooked.

Secondly and more fundamentally, risk assessment and governance architecture of the WFD and Water Reuse Regulation are intertwined. Hence, the European Commission published a Common Implementation Strategy dedicated to integrating water reuse in the planning context of the WFD in 2016.[75] The dependency of risk assessment and risk management frameworks may support a coherent legislative framework, an element of "good law", but it also creates many entanglements which overcomplicate the realisation of wastewater reuse and the achievement of the WFD's environmental objectives.[76]

[70] Water Reuse Regulation, Annex II (A) under 5.

[71] Water Framework Directive, Art. 4.

[72] Water Framework Directive, Annex X and Directive 2008/105/EC on environmental quality standards in the field of water policy, amending and subsequently repealing Council Directives 82/176/EEC, 83/513/EEC, 84/156/EEC, 84/491/EEC, 6/280/EEC and amending Directive 2000/60/EC of the European Parliament and of the Council (EQSD).

[73] *Supra* 49, 17.

[74] A water reuse system in Milan set up such an early warning system in which sensors constantly monitor pathogens, ensuring rapid responses in case pathogen presence above the MAVs is detected. See R Maffettone and B M Gawlik, "Technical guidance - water reuse risk management for agricultural irrigation schemes in Europe", Publications Office of the European Union, Luxembourg, 2022, doi:10.2760/590804, JRC129596, 77.

[75] European Commission, "Common implementation strategy for the water framework directive and the floods directive – guidelines on integrating water reuse into water planning and management in the context of the WFD" (2016).

[76] S Wuijts, P P Driessen and H F van Rijswick, "Towards More Effective Water Quality Governance: A Review of Social-Economic, Legal and Ecological Perspectives and their Interactions" (2018) 10(4) Sustainability 914; European Commission, n. 75.

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The risk assessment (and subsequent management) under the WFD is grounded in the river-basin management approach. Member States must assess the risks that human activity poses to the river-basin districts on their territory, including those of pollution, over-abstraction, altering the flow of surface waters and the artificial recharge for groundwaters.[77] This information then forms the basis of the risk assessment, in which the main question is how likely it is that the river-basin district that is subject to those particular pressures will fail to meet the environmental objectives of the Directive.[78] Subsequently, the WFD requires the Member States to create River Basin Management Plans which includes a Programme of Measures for their river-basin districts.[79] This Programme of Measures must include measures that are required under other pieces of EU legislation, including the Drinking Water Directive, the UWWTD and the Nitrates Directive even if their objectives differ from those of the WFD.[80] The Member States may also adopt additional measures if necessary to meet the WFD's objectives such as wastewater reuse.[81] Notably, the primary goal of wastewater reuse – increasing water security – does not align perfectly with the primary goal of the WFD – environmental protection. As highlighted before, wastewater reuse can endanger environmental protection if the wastewater is not treated to adequate standards prior to its use.

Therefore, the decision whether to engage in wastewater reuse for agricultural irrigation – or another purpose – does not just depend on the exemption possibilities laid on in the Water Reuse Regulation, but also on whether it aids in bringing a river-basin district closer to the WFD's environmental objectives. Here, scientific insights merge with policy decision-making at a busy regulatory crossroads. Moreover, if a Member State chooses to engage in wastewater reuse for agricultural purposes in one or more of its river-basin districts, then the Water Reuse Regulation's RMP and the WFD's River Basin Management Plan are inextricably linked. Notably, the risk assessment performed under the RMP informs whether wastewater reuse would aid or harm the achievement of the WFD's environmental objectives. Conversely, the risk assessment performed under the WFD would inform whether wastewater reuse is a suitable measure for that particular river basin, triggering recourse to the Water Reuse Regulation. Relatedly, the risk assessment under the RMP must consider the WFD's objectives, as well as those from other water-related legislation. Therefore, there is a legislative loop from the WFD to the Water Reuse Regulation and back, in which policy measures depend on the outcomes of each other's risk assessment. Such dependency may seem, on face value, like coherent legislation, but in practice it would require considerable time and resources to bring the governance architecture of the Water Reuse Regulation and the WFD into alignment.

The Groundwater Directive, since it has its own risk assessment framework, confounds the risk governance architecture even more. As noted previously, the Groundwater Directive contains most of the risk-management measures for groundwater quality. Similar to the WFD, the Member States must determine which groundwater bodies are at risk of failing to meet the WFD objectives and subsequently decide how to reverse this trend.[82] Water-quality standards and monitoring requirements are two of the risk-management measures for which the Groundwater Directive provides. The risk assessment also informs the decision whether to engage in wastewater reuse. While reuse in agriculture or groundwater recharge may bring the groundwater body close to the

[77] Water Framework Directive, Art. 4 and Annex II under 1.4.
[78] Ibid, Annex II under 1.5.
[79] Ibid, Art. 11.
[80] Ibid, Annex VI, Part A.
[81] Ibid, Annex VI, Part B under (x)
[82] Council Directive (EU) 2006/118/EC of the European Parliament and of the Council of 12 December 2006 on the protection of groundwater against pollution and deterioration (2006) OJ L 372, Arts. 4 and 5.

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quantitative targets, it may also pose risks to water *quality*. Therefore, the risk assessments under the Water Reuse Regulation and the Groundwater Directive are also interdependent: if groundwater bodies are at risk of failing to meet quantitative targets, reuse of wastewater for aquifer recharge may alleviate this risk but if the groundwater bodies are at risk of failing to meet qualitative targets, reuse of wastewater for aquifer recharge, or even more indirect uses such as agricultural irrigation, may increase this risk.

Three other EU Directives add another dimension to the risk governance of wastewater reuse, depending on to what end the reclaimed water is used. First, the recast UWWTD establishes the legal framework for collecting and treating urban wastewater to certain quality standards. Once wastewater has been treated to the appropriate level under this Directive, it can become a potential source for reuse under the Water Reuse Regulation. The recast UWWTD therefore ensures the removal of many pollutants and the Water Reuse Regulation then sets further quality standards for agricultural irrigation. Together, they create a regulatory chain from wastewater collection to treatment, to further treatment, and to safe and controlled reuse. Second, the Nitrates Directive aims to reduce water pollution from nitrates from agricultural sources.[83] It requires the Member States to designate "vulnerable zones", territories which contribute to nitrogen pollution in waters.[84] In these territories, measures must be taken to reduce nitrogen pollution of water sources. Therefore, using reclaimed wastewater in these vulnerable zones must be subject to extra scrutiny due to the potential of nitrogen pollution stemming from this reclaimed wastewater. Third, if water reuse for agricultural irrigation occurs in or close to an area that is used for the abstraction of drinking water, the corresponding Risk Management Plan must account for the obligations from the Drinking Water Directive.[85] The aim of the assessment and management of risk in areas in which water is abstracted for drinking should be to avoid the deterioration of abstraction zones and to reduce the level of treatment that is required for consumption.[86] Therefore, hazards and hazardous events in abstraction zones must be identified.[87] Wastewater reuse for agricultural irrigation or even managed aquifer recharge may well be such a hazardous event, which creates a link between the Drinking Water Directive and the Water Reuse Regulation. If the risk assessment shows that wastewater reuse does indeed pose risks to the abstraction zone, then risk-management measures must be taken.[88] The most logical risk-management measure to prevent risks to abstraction zones that are vulnerable to the effects of the use of reclaimed wastewater in agriculture is not engaged in wastewater reuse in these zones. This said, given the relationship between water quality and water quantity, increasing water levels in abstraction zones through the indirect reuse of wastewater may also improve water quality, provided that the quality of the reclaimed water is sufficient.

b. Chemical safety and risk regulation

Beyond environmental law, the rules on chemical safety also inform the regulation of the risks of wastewater reuse. They do so "upstream" – for example, the REACH Regulation by limiting the use of certain substances reduces the likelihood that substances that pose threats to human or environmental health will be present in the wastewater streams that are reclaimed. Analysing the EU chemicals legislation exceeds the scope of this paper, but

[83] Council Directive of 12 December 1991 concerning the protection of waters against pollution caused by nitrates from agricultural sources (91/676/EEC) (1991) OJ L 375, Art. 1.

[84] Ibid, Art. 3(2).

[85] See also, Water Reuse Regulation, recital 17 and Annex II (C) under 7.

[86] Council Directive (EU) 2020/2184 of the European Parliament and of the Council of 16 December 2020 on the quality of water intended for human consumption (recast) (2020) OJ L 435, recitals 17 and 18.

[87] Ibid., Art. 8(2).

[88] Ibid, Art. 8(4).

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other scholars have similarly analysed the risk governance under the REACH Regulation and the EU Chemical Strategy for Sustainability.[89]

c. Interim conclusion

It was previously noted that the Water Reuse Regulation fails to regulate many pollutants, to clearly divide responsibilities, and to effectively create a secure science-policy interface. This section showed that the broader EU regulatory framework, which comprises the WFD, the EQSD, the UWWTD, the Nitrates Directive, the Groundwater Directive, the Drinking Water Directive and the REACH Regulation, addresses the first of these gaps, in that it covers many additional pollutants. The planning system of the WFD, that is, the system of River Basin Management Plans, also clarifies the division of responsibilities to some degree, at least at the institutional level. However, this all does come at the cost of exponentially increasing the regulatory burden, especially due to the interlinkages of the risk assessments and risk management measures between these regulatory instruments. The complexity of the water system is thus mirrored by the complexity of the risk governance frameworks in the EU legislation that deals with or touches upon freshwater, hindering the uptake of wastewater reuse practices. The next section turns to the EU environmental principles, which further clarifies the division of responsibilities, but does not resolve all regulatory gaps and frictions.

3. The third layer of risk governance: the principles of EU environmental law

Risk regulation in the EU did not begin with the introduction of water-quality standards. Instead, it evolved within a broader legal and institutional context, which, in turn, emerged from the progressive development of environmental law since the 1970s. This development culminated in the sophisticated system of risk governance of which the Water Reuse Regulation is a manifestation. At the core of this framework are the four foundational principles of EU environmental law: the precautionary principle, the principle of prevention, the polluter-pays principle, and the principle of rectification at the source. These principles are too broad and vague to be analysed against the IRGC framework. Nonetheless, these principles direct and influence EU laws and aid in closing regulatory gaps, which merits their discussion in this context.

The precautionary principle occupies a dominant role in the discussion on risk regulation and EU law.[90] Enshrined in Article 191(2) TFEU and echoed throughout EU environmental legislation, it acts as a "constitutional clause" for EU risk regulation. In theory, it authorises protective regulatory action even when there is no scientific certainty about environmental harm.[91] In practice, uncertainty is a feature of almost all environmental and health risks, particularly in emerging domains such as wastewater reuse; consequently, precaution is a returning feature in the regulation of such fields. Importantly, the Water Reuse Regulation requires that risk assessment be conducted with the precautionary principle in mind, thereby tying the legal standard of precaution to scientific practice.[92] This link institutionalises the science-policy relationship: science is expected to produce knowledge that guides regulatory decisions and justifies regulatory

[89] S Scholz et al., "The EU Chemicals Strategy for Sustainability: An Opportunity to Develop New Approaches for Hazard and Risk Assessment" (2022) 94 Archives of Toxicology 3161; L Posthuma et al., "Towards "One substance – one assessment": An analysis of EU chemical registration and aquatic risk assessment frameworks" (2021) 19 Integrated Environmental Assessment and Management 111692; European Chemicals Agency (ECHA), *Report on the Operation of REACH and CLP 2021* (ECHA 2021).

[90] R von Schomberg, "The Precautionary Principle: Its Use Within Hard and Soft Law" (2012) 3(2) European Journal of Risk Regulation147.

[91] M Lee, *EU Environmental Law, Governance and Decision-Making* (Hart 2014).

[92] Water Reuse Regulation, Annex II(A)(5).

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action in the face of unresolved uncertainty.[93] The remaining tension between precaution and risk tolerance is then left to the (national) regulator to decide on, with, of course, input from science. This reflects a broader pattern in EU environmental law, where scientific input is in part decentralised and shaped by national administrative traditions.[94]

The prevention principle, though it is conceptually close to the precautionary principle, is deterministic. It applies to known risks and requires early intervention to prevent their materialisation. This principle is operationalised throughout the Water Reuse Regulation by water-quality standards, mandatory monitoring protocols, and the requirement for site-specific RMPs. These measures reflect the regulatory logic of pre-emption: they are meant not to respond to incidents but to prevent them altogether.[95] The rectification-at-the-source principle and the polluter-pays principle embed accountability into risk regulation. The former prioritises prevention at the point at which harm originates while the latter demands that those who are responsible for pollution bear the cost of its control. Although these principles are not particularly prominent in the Water Reuse Regulation, they shape the logic by which it ascribes responsibilities to actors: reclamation-facility operators and upstream polluters should thus carry the heaviest regulatory and financial burdens.

In sum, the principles of EU environmental law provide normative guidance for the assessment and management of the risks that are associated with wastewater reuse. They establish the outer legal boundaries within which decisions must be made, particularly under conditions of uncertainty. However, being abstract, they offer few concrete answers to the actors who are involved in the actual governance of wastewater risk. As a result, operators, competent authorities, and policymakers must govern risk within these outer boundaries by relying on the more robust legal framework of the WFD, EQSD, UWWTD, and – where necessary – the Nitrates Directive and Groundwater Directive, as well as on the text of the Water Reuse Regulation. While the rectification-at-the-source principle and the polluter-pays principle help in clarifying some of the responsibilities, the precautionary and prevention principles, while subtly present in the Regulation and its RMP, do not offer the same concrete tools to operationalise wastewater reuse.

IV. Conclusion

Having reviewed each of the three layers of regulation in isolation, some general conclusions about regulatory gaps and the means that are available for resolving them can be drawn. The IRGC framework for risk governance has four phases: pre-assessment, risk appraisal, risk characterisation and evaluation, and risk management. The Water Reuse Regulation follows different steps, laid down in both the text of the Regulation itself as well as the requirements for the RMP. This hybrid or multi-level nature – a foundational risk management at the EU level combined with additional, local and context-dependent risk management measures – can also be found in EU water-related legislation such as the Bathing Waters Directive and the Drinking Water Directive. The exact success of this regulatory choice for wastewater reuse for agricultural irrigation will have to be seen with the first review cycle in 2028.

To ensure the Regulation's success and the widespread and safe reuse of reclaimed wastewater, the following remaining legislative issues must be addressed. First, the

[93] A Quintavalla and O Yalnazov, "Regulating Eco-Innovation in the European Union" (2025) 68(3) Journal of Environmental Planning and Management 539, 549.

[94] A Čavoški, "Science and law in Environmental Law and Policy: The Case of the European Commission" (2020) 9 Transnational Environmental Law 263.

[95] H K Gilissen, E de Jong, H F van Rijswickand and A van Wezel "Towards More Effective Environmental Risk Regulation: An Analysis of Complementary Effects between Administrative Environmental Law and Tort Law in the Regulation of Environmental Risks, with a Specific Focus on Chemical Mining Activities in the Deep Subsoil" (2021) 18(1–2) Journal for European Environmental & Planning Law 77.

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regulation of pollutants must be clarified. While every relevant known pollutant is regulated in theory, be it through the Water Reuse Regulation, the broader EU legislative framework such as the recast UWWTD, or the environmental principles, in practice, there is no comprehensible, easy-to-navigate, legislation. Clarity could come from an EU body, a Member State or local parties who are prepared to share their knowledge, such as food-safety authorities and environmental protection agencies.

Second, the division of responsibilities for the safe operation of a water-reuse system must be rendered more comprehensible. A clear division of responsibilities is necessary for accountability when incidents do occur *ex post*, but also to understand who is in charge of which element of the water reuse system *ex ante*. The EU environmental principles, the broader EU legislative framework on water reuse, and the Regulation combined sketch the contours of what the division of responsibilities should look like, but the deference to Member States and local water reuse actors may not strike an effective balance between administrative subsidiarity and harmonisation. Governance research on institutional cooperation could help inform successful divisions of responsibility and decision-making.

Third, and perhaps most crucially, strengthening the science-policy interface is key to effective and safe wastewater reuse practices. The ICRG risk governance framework promotes continuous exchange of knowledge between scientists, lawmakers and policy-makers, operators and the public. The EU's precautionary principle similarly demands constant interaction between science and policy for determining acceptable risks and subsequent actions. This interaction is also important in the implementation of the Regulation, specifically in risk assessment and management as central elements of the RMP.

The involvement of EU and national scientific partners in the creation and implementation of the RMP is, for the most part, left to the discretion of the Member States and local responsible authorities. Engaging in wastewater reuse must be done based on a deep understanding of the water system on the one hand, and the entire water-related EU, national and local regulatory framework on the other hand. Therefore, the JRC and the European Environmental Agency, for example, would be fundamental institutions located at these crossroads to systematically create and share insights. However, such integration depends on effective interface between scientists and policymakers not just at EU level, but at all regulatory levels where legitimacy,[96] theory-to-practice translations,[97] and scientific integrity,[98] among others, are ensured. In the context of wastewater reuse, this means that a robust science-policy interface must be ensured prior by EU, national and local regulators in order to strike the right precaution–risk-tolerance balance that underpins the Regulation and wastewater reuse practice.

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[96] N Wagner, S Sarkki and T Dietz, "More than Policy Neutral: Justifying the Power of Science-Policy Interfaces through Legitimacy" (2024) 21 Earth System Governance 100219.

[97] N Kotamäki et al., "Strategies for Integrating Scientific Evidence in Water Policy and Law in the Face of Uncertainty" (2024) 931 Science of the Total Environment 172855.

[98] M J Colloff, R Q Grafton and J Williams, "Scientific Integrity, Public Policy and Water Governance in the Murray-Darling Basin, Australia" (2021) 25 Australasian Journal of Water Resources 121.

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